INDEXED.

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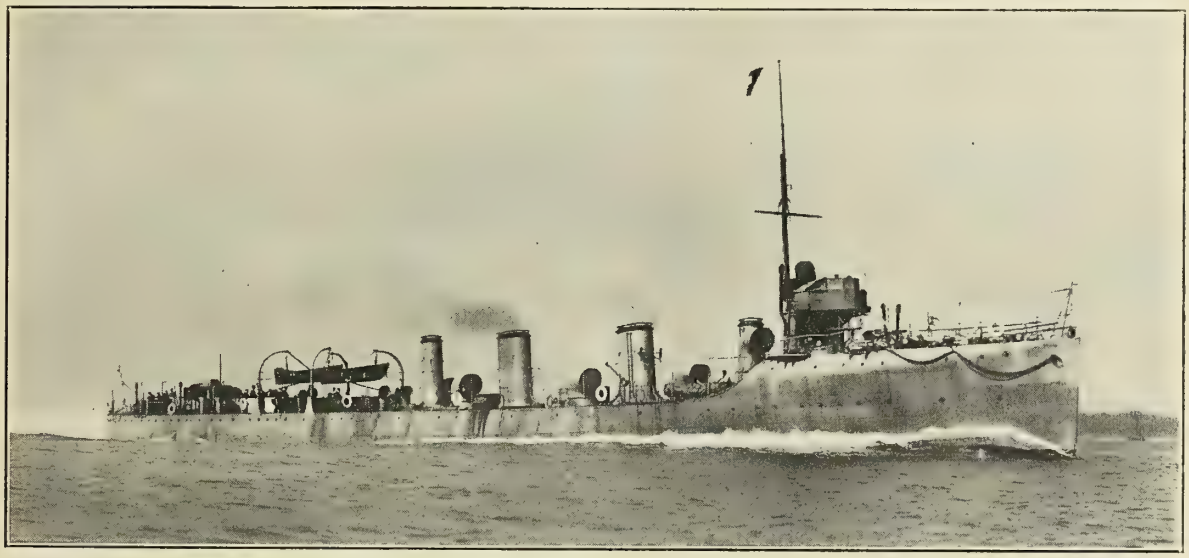
THE FASTEST SHIPS IN THE WORLD.

At the beginning of every year it is customary to review the progress made in shipbuilding during the previous twelve months, and by picking out the salient features of each contributory line of evolution to strive to form the best idea of the directions of greatest progress or the tendencies of future development. Two facts stand out at present above all others. The first, affecting merchant steamers alone, is the enormous improvement in the comfort and luxury of ocean voyaging; the second, with which we are now concerned, is the great rise in absolute speed which, though very marked in special cases in the mercantile marine, is much more general in the warships of the world. It is, however, impossible to form any opinion of value by simply considering the progress of one particular year, and we propose to deal with the growth in speed since the beginning of the century.



BRITISH TURBINE-DRIVEN DESTROYER MOHAWK, STEAMING AT OVER 34 KNOTS ON OFFICIAL TRIAL TRIP.

It is a very simple matter—given the money—to produce a small vessel of abnormal speed. Cases such as the famous *Arrow* or the *Turbinia,* in which absolutely everything is sacrificed to pace, do not represent by any means the acme of naval architecture. Interesting they certainly are, but their use and value are doubtful and transitory. When, however, it becomes a question of attaining not only a very high speed, but of *maintaining* it, and of carrying weight in addition, be it cargo or coal, guns or armor, the problem becomes different and more difficult, while if, in addition to this, the vessel must be commercially profitable, the conditions become extremely hard to fulfil. The case of the recent Cunard vessels is one of the most up-to-date examples available. In warships, of course, the question of cost hardly enters, and use can be made of designs or materials that dividend earning concerns could not afford, and in which at the same time there is neither the need nor the inclination to take the risks or reduce the margins that are accepted in naval work. The two cases must therefore be treated separately.

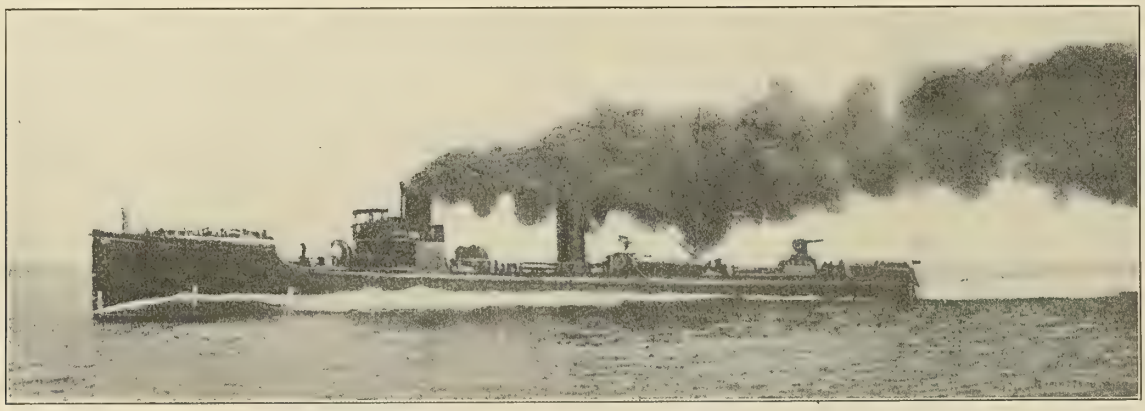
For a floating ship-shaped body propelled on the surface of the water speed has also a relative value, the real measure being its ratio to the square root of the length, viz.: $\frac{V}{\sqrt{L}}$, where V is speed in knots and L is length in feet. In cases where the value lies between 0.5 and 0.7 the ship is being driven at a very moderate and economical speed; between 0.7 and 1.0 we find the speed of mail steamers and battleships, and between 1.0 and 1.3 we get cruisers and channel steamers. Beyond 1.35 we cannot go in full sized vessels under present conditions, because it is not possible to get enough engine and boiler power into the ships, on account of the fact that the floor space available in the ships is not sufficient; but it can be done in torpedo craft by using very high-speed engines and excessive forced draft to the boilers. In these ships the ratio of $\frac{V}{\sqrt{L}}$ is between 1.8 and 2.2, and only in very exceptional cases has the latter ratio yet been exceeded. The reason underlying the importance of this ratio is that the wave-making resistance of the ship does not increase regularly, but in humps of varying magnitude, the first of which occurs at a speed of about 1.4 to 1.6 times $\sqrt{L}$. From the above it follows that speed should always be considered relatively as well as absolutely.

WARSHIP SPEEDS.

One of the earliest and relatively fastest vessels built was the *Forban* of the French navy, which was constructed by

Normand at Havre in 1895. She attained 31.2 knots, though only 144 feet long, displacing 125 tons and requiring 3,950 I. H. P. For some years she held the record for speed, and was always a remarkable vessel, her success being almost entirely due to her exceptional machinery. The *Turbinia,* early in 1897, was the first vessel to break the *Forban's* record. Up to 1900, about eighty vessels had been built which had, on genuine official trials, attained a speed of 30 knots. Sixty of these were in the navies of England (48) and Japan (12). They were all propelled by reciprocating engines, and for the most part averaged from 210 to 215 feet in length by 20 to 22 feet breadth. The power was about 6,500 I. H. P.

In 1900, however, the trials of H. M. S. *Viper* astonished everyone. This vessel still holds the record for speed, having attained over 37 knots when displacing 370 tons. She was of exactly the same dimensions as the 30-knotters, but with larger boilers—having 275 square feet of grate area, compared with about 220 in the other ships, the respective heating surfaces being 15,000 and 12,000 square feet. The *Viper* was the first vessel to be fitted with Parsons turbines (except the *Turbinia*), and the results of her trials are given in Table I. The turbines weighed about 7½ percent less than the reciprocating engines of only half the power fitted in the sister ships.



THE GERMAN TURBINE-PROPELLED TORPEDO BOAT DESTROYER G137 AT HIGH SPEED.

TABLE I.

Trial.	Speed in Knots	Equivalent I. H. P.	R. P. M.	Coal Burned per Hour. Pounds.	
				Total.	Per I.HP.
Maximum power..... (1 hour)....	37.113 max. / 36.58 mean	13,000	1,180	34,500	2.61
3-hour coal consumption.	33.83	10,300	1,050	25,700	2.49
3-hour official trial.....	31.118	8,350	950	19,800	2.38
12-hour slow speed.....	15.0	750	450	3,000	4.03

The *Viper* was lost by running ashore, and the *Cobra,* a very similar vessel of slightly slower speed, broke her back through structural weakness and sank in the North Sea. The loss of the *Cobra,* coupled with signs of weakness in many of the 30-knotters, resulted in a change of policy in the construction of these high-speed vessels, and structurally heavier hulls were afterwards required, the consequent sacrifice in speed being accepted. In England, therefore, between 1901 and 1905 no really fast destroyers were build for the British navy. One exceptionally fast vessel, the *Mode,* was built by Yarrow for the Swedish government in 1902, a speed of 32.4 knots being obtained; but in other navies no attempt was made to exceed 30 knots—in fact, Germany was content with 27 knots and France and Italy with about 28. Until this year hardly any new torpedo craft have been constructed in the United States for some years.

Towards the end of 1905, however, the British Admiralty laid down five ocean-going destroyers, most of which have just completed their trials. These vessels and the subsequent batches of two laid down in 1906 and five in 1907 are all about 250 to 280 feet long, and displace about 850 tons. The speeds attained on a six-hour trial have varied from 33.14 in the *Cossack* to 34.3 in the *Mohawk,* which latter at present holds the record for being the fastest ship afloat.* Propelled by Parsons turbines of about 17,000 horsepower, these vessels are very remarkable in many ways. They carry a poor armament (only three 12-pounders and two 18-inch torpedo tubes), but are especially built for sea-keeping in company with the fleet. They carry 160 tons of oil fuel.

Another remarkable vessel, *G137,* was completed in 1907 by the Germania Company, at Kiel. Also propelled by turbines, *G137* is extremely similar to the British river class boats of 26 knots speed that were built in 1903 and 1904. She attained a speed of 33.1 knots on her trials at 580 tons displacement, and carries no less than four torpedo tubes, one 15-pounder and four smaller guns.

The extraordinary success that attended the speed trials of all these very fast vessels of 1907 has gone a long way to assure naval architects of the success of H. M. S. *Swift,* which is by far the most remarkable ship now under construction, from the speed point of view. Built for a speed of 36 knots on an eight-hour trial under service conditions, the vessel displaces no less than 1,800 tons on 10-foot 6-inch draft. The armament will include four 4-inch guns. The ship was launched on Dec. 7, 1907.

Table II. shows the leading dimensions and speeds of all these vessels, together with the dates of their trials. The years 1903, 1904, 1905 and 1906 do not show any progress of importance, 30 knots being the extreme speed attained, and most navies contenting themselves with slower vessels of more durable construction. The performance of *G137* is remarkable in that it was attained with coal fuel. Oil fuel seems likely to become an absolute essential in the design of these very fast craft, for it admits of several advantages which cannot be ignored.

(1) Greater calorific value, giving either greater radius of action on same weight of fuel, or less weight for same radius.

(2) Greatly reduced stokehold space required, especially in a fore-and-aft direction.

(3) Greater ease of manipulation.

It is interesting to note how the length of these vessels has increased in proportion to the speed; the ratio has remained very constant during the last seven years.

In all these cases we have considered vessels of abnormal absolute speed, in which great sacrifices of armament and protection have been made to secure pace. We shall proceed next

* Eclipsed by the sister-boat *Tartar,* which, on Dec. 17, averaged 35.36 knots for 6 hours, and made 1 mile at the rate of 37.037 knots.

to work back to vessels of the cruiser type, which are also relatively high-speed vessels. The first step in the connection is obviously through the *Scout* class of cruiser, and as it happens that these vessels are remarkably similar in general dimensions to the *Amethyst* type of third-class cruiser, we have compared these vessels in Table III., adding the most recent type of second-class cruiser. After this point in British naval practice there is a radical change. The size of vessels necessitates their being protected by external armor, and the necessary compromise of weights involves a reduction in machinery. We then begin to get to comparatively slow proportionate speeds. Thus, for instance, the very fast cruisers of the *Good Hope* and *County* classes of 500 and 440 feet in length, have speed-length ratios of only 1.075 and 1.1, respectively.

TABLE II.

Vessel	Date	Length feet	Speed, knots	$\frac{V}{\sqrt{L}}$	Horse-power	Displacement, Tons	Horse-power per Ton D	Admiralty Coefficient
Forban	1895	145	31.2	2.59	3,950	125	31.6	192
Turbinia	1897	100	33.0	3.3	2,200*	44.5	49.5	205
English Navy	'98-'00	210	30.0	2.07	6,500	320	20.3	194
Japanese Navy	1899	220	31.0	2.09	7,000	315	22.2	197
Viper	1900	210	37.0	2.55	13,000*	370	35.1	200
Mode	1902	220	32.4	2.175	7,500	400	18.8	246
G 137	1907	235	33.1	2.16	13,400*	580	23.1	188
Cossack†	1907	270	33.2	2.02	17,500*	830	21.1	185
Swift†	1908	345	36.0	1.94	33,000*	1,800	18.3	209

* Turbine machinery. † Oil fuel.

TABLE III.

Vessel	*Swift*	*Sentinel*	*Amethyst*	*Encounter*
Length	345′	360′	360′	355′
Breadth	35′	40′	40′	56′
Displacement	1,800	2,800	3,000	5,800
Speed	36	25.5	23.6 (21.75 design)	21.0
Horsepower	33,000	17,500	14,000 (10,000 design)	12,000
Armament	4 4-inch	10–12 prs. 8–1½ prs.	12 4-inch 8–3 prs.	11 6-inch 9–12 prs.
Protection	0 tubes nil	2 tubes armored deck	2 tubes armored deck	2 tubes armored deck
Coal at normal draft	180 tons (Oil fuel)	150 tons	300 tons	500 tons
Date	1908	1905	1904	1902
$\frac{V}{\sqrt{L}}$	1.94	1.344	1.245	1.13

An Electrically Operated Sea-Going Steam Dredge.

The seagoing steam dredge *Thor* is the first instance of a dredge designed for purely electrical operation of all winches and mechanisms, inclusive of the bucket drive. It has been constructed on plans by Mr. W. Meiners, while the electrical part was supplied by the Siemens-Schuckert Works.

The *Thor* is used at the mouth of the river Weichsel as a bucket dredge for pontoon and floating operation. Its output is 170 cubic meters (222 cubic yards) of dredging ground per hour, the maximum depth of dredging being 8 meters (26 feet), and the traveling speed 12 kilometers (7.45 miles) per hour (6½ knots). The length is 44.5 meters (146 feet), breadth across frames 8.5 meters (28 feet), depth amidships 3.3 meters (10 feet 10 inches), and draft in full working order 2.16 meters (7 feet 1 inch).

The boiler and engine rooms are situated amidships, and the rooms reserved for the crew, as well as the chain and utensil compartments, in the bow and stern. On the deck there are located the chart room and kitchen, with the pilot's cabin on top of the latter, while the deck houses are situated sideways. Both petroleum and electrical lighting have been provided, and all the rooms are ventilated efficiently.

The boiler plant comprises two horizontal fire-tube boilers with return tubes, designed for a pressure of 9 atmospheres (132 pounds per square inch), and a combined heating surface of 180 square meters (1,937 square feet). Two steam engines of 175 horsepower each, running at 185 revolutions per minute, serve to operate the propellers and centrifugal pumps, while a third steam engine, of 220 horsepower output at 350 revolutions per minute, is directly coupled on the one hand to a continuous current shunt dynamo, with reversing poles, of 82 kilowatt output and a tension of 10 to 110 volts at the terminals, for operating the upper tumbler; and on the other hand to a direct current compound wound dynamo of 46 kilowatts and 110 volts, for operating the various winches, while serving at the same time as exciter machine for the other dynamo (Fig. 2). A fourth steam engine of the Deaval type, of an output of 25 horsepower at 500 revolutions per minute, is coupled to a 12.4-kilowatt direct current shunt dynamo with a tension of 110 volts at the terminals, which is intended for supplying the electric lighting plant.

The four steam engines referred to are provided with a

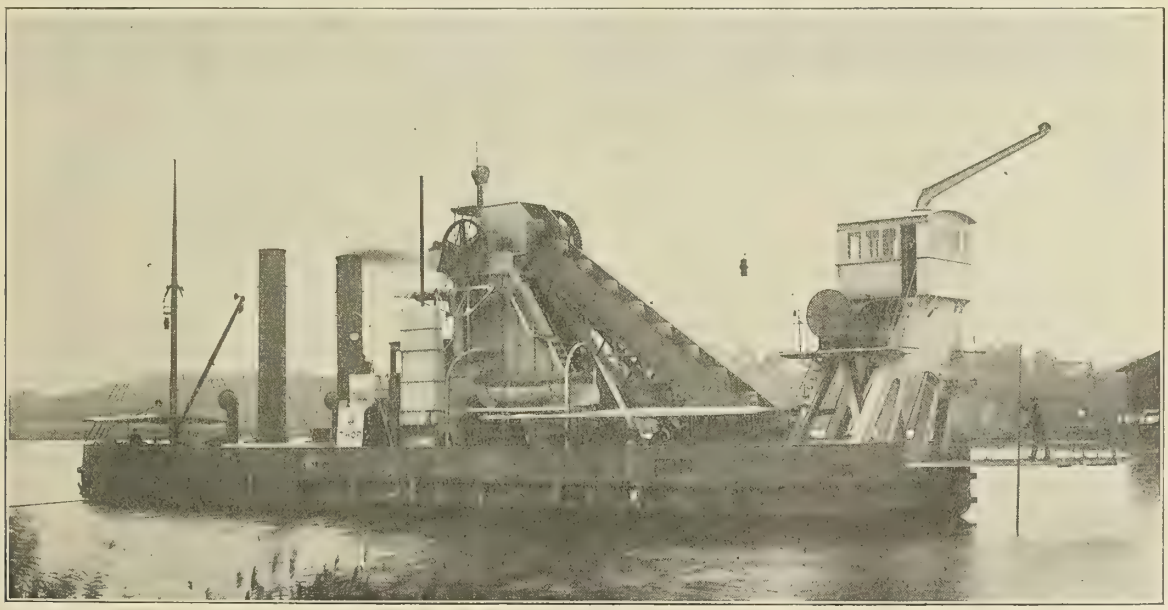


FIG. 1.—GENERAL VIEW OF THE THOR, A BUCKET DREDGE OPERATED ENTIRELY BY ELECTRICITY.

common surface condensing plant. The three dynamos are of the multipolar type, and of a design especially adapted for use on board ship, a special feature being the small space requirements in the direction of the axis, and the ease of coupling to quick-running machines.

The motor operating the tumblers has been designed on similar lines. A switchboard with the necessary switches, fuses and measuring instruments has been provided in the engine room for each of the three dynamos. The connections have been so designed as to allow the winch-operating dynamo to be used also in connection with the lighting plant, and the lighting dynamo for the operation of the winches and cranes. To this effect the lighting and power switchboards are connected together, a double-pole switch on each switchboard enabling, on the one hand, the lighting mains to be connected both to the lighting and power machines, while on the other hand, part of the power circuit can be switched on, both to the power and lighting dynamos.

The hoisting machines and auxiliary machinery serving for the dredging operations proper can be operated only from the power dynamo. A special feeder 310 square millimeters (0.48 square inch) in copper section connects the power switchboard to a switchboard arranged in the pilot house, from the bus bars of which the several circuits for the auxiliary dredging machinery are branched off. The steering apparatus, as well as the reversing shunt controller of the dynamo operating the tumbler, are installed in the pilot house, whence they are controlled. The advantage of electrical power transmission is inferred from the fact that one man is able, without leaving his post, to control all the auxiliary machinery used in dredging.

The dredging buckets have each a capacity of 0.24 cubic meters (8½ cubic feet) on being filled horizontally, with a mean dredging depth of 5.5 meters (18 feet); they have cast-on double joints at the back, which are connected to the simple intermediary joints by means of hardened joint bolts. The bucket chain is guided by rollers located on two framework girders, constituting a bucket ladder of 40 degrees inclination, with an average dredging depth of 5.5 meters. The lowering and lifting of the ladder is effected by means of a 12-horsepower series motor operating with 510 revolutions per minute a winch located on the stern jack. This motor is handled by a reversing controller of the usual design, with short-circuit position and magnetic blowing.

The pentagonal lower tumbler is located at the lower end of the bucket ladder, in which it is free to move. The pentagonal upper tumbler is located on the middle jack, and is operated by a shunt motor of 100-horsepower output with 285 revolutions per minute, through the intermediary of two spur wheel gearings with hydraulic friction clutch. This motor can be regulated between zero and full speed, the arrangement adopted being the Ward-Leonard system. It is provided with separate excitation at 110 volts from the power dynamo, while the tumbler dynamo has a shunt exciter located in the pilot house, and which has been so arranged as to enable the field of the tumbler dynamo to be reversed, in order to impart a backward motion to the bucket chain. The hydraulic friction clutch is intended to reduce to an admissible limit the torque transmitted by the tumbler motor, it being caused to slide whenever the buckets are put to specially heavy strain, due to mechanical resistance in the dredging ground.

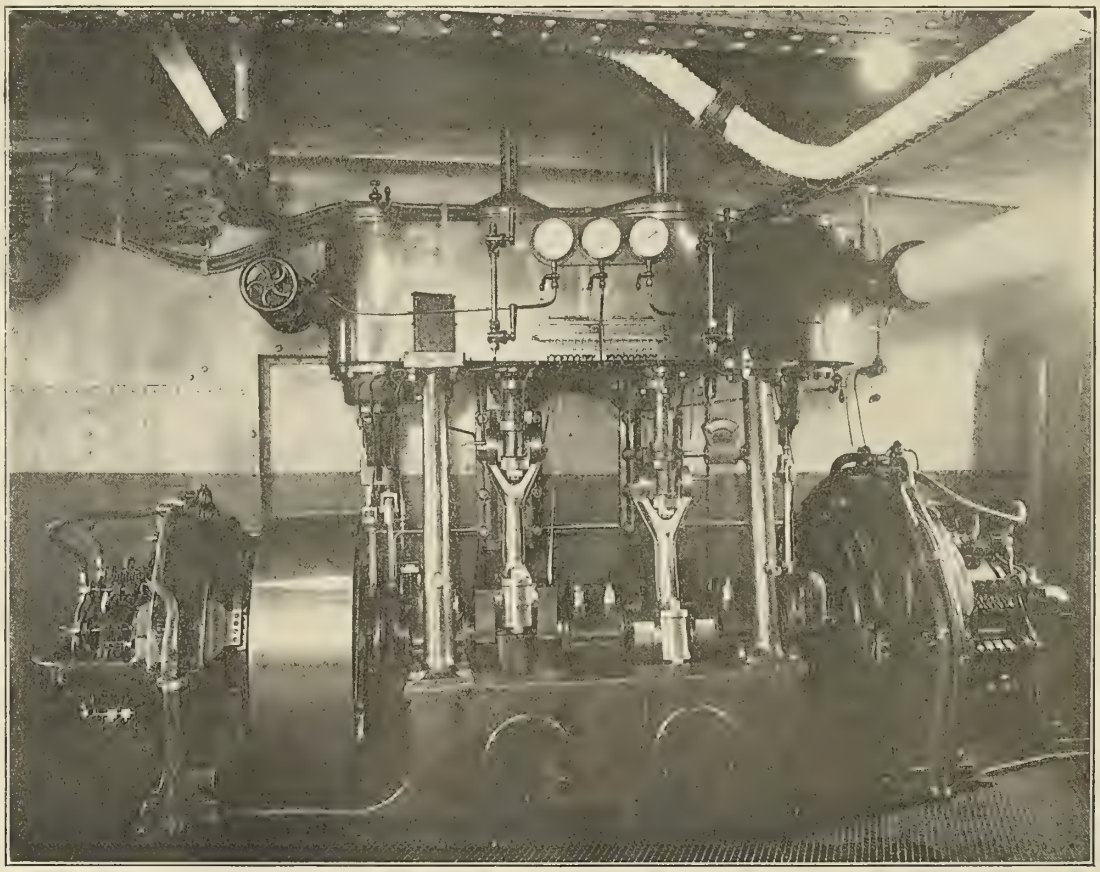


FIG. 2.—COMPOUND ENGINE OPERATING GENERATORS ON THE GERMAN BUCKET DREDGE THOR.

The dredged soil is dropped into a hopper, with chutes connected to both sides of the vessel; at the summit there is a valve for distributing the soil. The chutes are hauled in by series motors of an output of 2 horsepower with 530 revolutions per minute, handled by ordinary reversing starters. The dredged soil can also be poured out through an opening in the stern chute into a tank below deck, whence it is sucked in with

an addition of outside water by one or two centrifugal pumps 1.5 meters (59 inches) in diameter, in order to be carried away a distance of 600 meters (1,970 feet), in a lateral pipe 450 millimeters (18 inches) in clear width, the terminal height being 3 meters (10 feet) above the level of the water. The suction and pressure conduits of the two centrifugal pumps have been so arranged as to enable both pumps to work jointly, or each pump separately.

The dredge is maneuvered on the spot by the aid of a stern winch, two lateral chain winches and a bow winch (anchor winch), while three hauling winches (Fig. 3) have been provided for hauling the steam pontoon. All the winches, as seen from the figure, have been so installed on deck as to leave the latter as clear as possible, while the winches arranged in groups require for their operation the smallest possible number of men. All the motors are operated through worm wheel transmission by slowly running electric motors, which are entirely inclosed to protect them against rain and spray; the tumbler motor is in addition provided with a ventilator. The motor operating the anchor winch is installed below deck in a protected position, and therefore is not of the inclosed type.

FIG. 3.—STERN OF THE ELECTRICALLY OPERATED GERMAN DREDGE THOR.

The stern winch, the rope drum of which can be thrown out of gear, is operated by a series motor of 14 horsepower and 420 revolutions per minute. The four winches provided for the lateral chains are driven by shunt motors, and the bow winches by a series motor. These five motors are otherwise identical in design, giving an output of 12 horsepower with 510 revolutions per minute.

The controlling apparatus for the stern and bow winches, as well as for those operating the lateral chains, is located in the pilot house, and has been designed as controller rollers, each two corresponding chain winches having a common controller in connection with a switch. The latter enables both motors to be operated simultaneously (when one winch will haul in and the other pay out an identical length of chain), while both motors can be made to operate independently in hauling in or paying out the chain corresponding to one or two winches. In order to insure an entirely uniform winding and unwinding of the chains, while regulating the speed of the latter, a shunt regulator has been provided in the pilot house for each chain winch motor. For the anchor winch, has been installed in its immediate neighborhood another controller roller, enabling the winch if desired to be handled from that part of the ship. Means have, however, been provided for allowing the winch in each case to be started, either from the pilot house or from the winch itself, but never in both ways. The ends of the lateral chains are run either into a pit below water, or over the deck, to be caught below deck in rotary iron boxes.

The three hauling capstans are operated by series motors with watertight oil-cooled starter of an output of 7.6 horsepower with 450 revolutions per minute.

Two cranes of a capacity of 3,000 kilograms (6,614 pounds) have been provided for hauling the anchor, removing the chain pit, withdrawing the lower tumbler and dredging buckets, etc. These cranes are driven by series motors of 3 horsepower output with 520 revolutions per minute, the motor of the stern crane being of the inclosed type, and that of the bow crane of the open type. Both motors are handled by controllers arranged close to the cranes. For hauling greater loads on deck, as well as for loading coal, has been installed a loading pole, which at the same time serves as signaling pole.

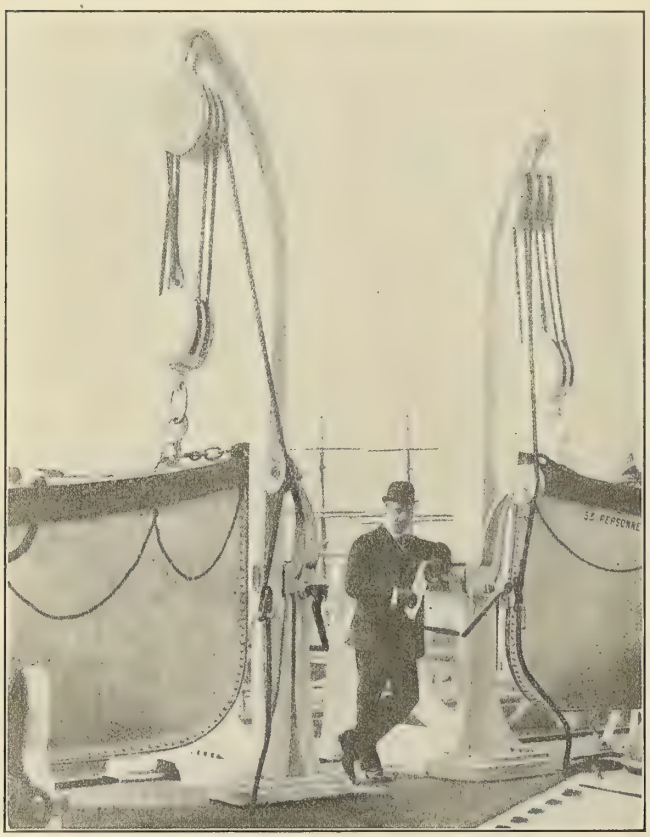
The electric lighting plant comprises a projector for 30 amperes and parabolic mirror 400 millimeters (15¾ inches) in diameter, four flame-arc lamps for 10 amperes intended for lighting the deck, in addition to about 40 glow lamps of 16 and 25 normal candlepower, in the various compartments. All electric conductors are rubber-insulated bitumenized cables with protective iron bands, which are carried in groups below deck alongside the walls and ceilings, where they are readily accessible.

APPLIANCES FOR MANIPULATING LIFEBOATS ON SEA-GOING VESSELS.*

BY AXEL WELIN.

The last time I had an opportunity of watching regulation boat drill on a large liner the conditions were the most favorable—broad daylight, no wind and the ship in harbor. All the various appliances were evidently kept in splendid order, and each boat's crew as fully acquainted with its duty as circumstances permitted. The ship had, however, a faint list—less than 1 degree—but that alone was sufficient to cause quite apparent difficulty in manipulating the boats.

The sensitiveness in this respect of the usual davit is, therefore, one of the greatest of the many drawbacks incidental to



THE DAVIT ARRANGEMENT ON LA PROVENCE, SHOWING SHEAVES.

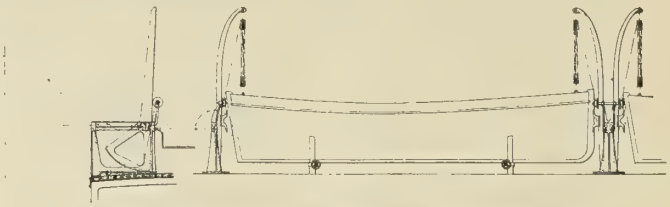
the system. Three to 4 degrees list of the ship instantly reduces its boat capacity by one-half. The Board of Trade regulations, consequently, prescribe in the case of cargo steamers, that the ship shall carry sufficient boats on each side to accommodate the whole crew. That a similar rule does not apply to passenger steamers, where evidently it is so much more called for, is simply the result of the practical impossibility of carrying it into effect.

But the objection which cuts to the very root of the evil is that the system does not and cannot give the crew proper control in handling the boat. The slightest rolling motion of the vessel, when once the guys are loose, is apt to throw the boat into a swinging motion highly dangerous alike to itself and the crew. Without prosecuting this criticism further, I will now formulate the principal requirements of an ideal system of davits, such as they present themselves to me after several years of keen and careful study.

1. The boat must in all circumstances, and in every position, be under efficient control.

2. A moderate list of the ship must not prevent or appreciably retard the manipulation of the boat.

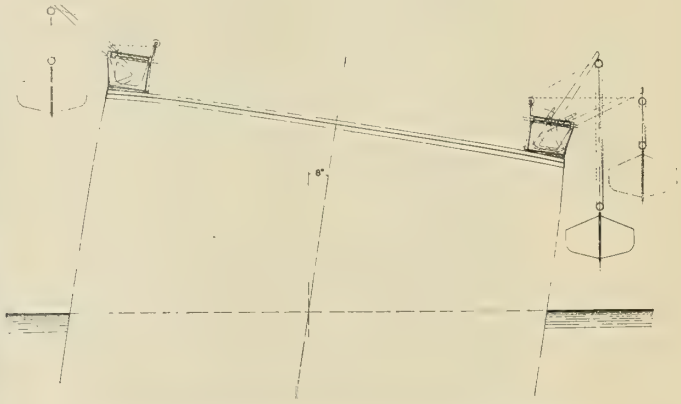
3. The mechanism should be of the simplest possible nature, and always "get-at-able."



THE USUAL TYPE OF WELIN QUADRANT DAVIT OUTFIT.

4. The manner of manipulating the davits must be such as to preclude any necessity for expert training, and all possibility of confusion in cases of accident.

5. Cost, weight and deck space occupied are all matters which must be taken into account, even if they do not come within the scope of the subject, when treated from a strict "life-saving" point of view.

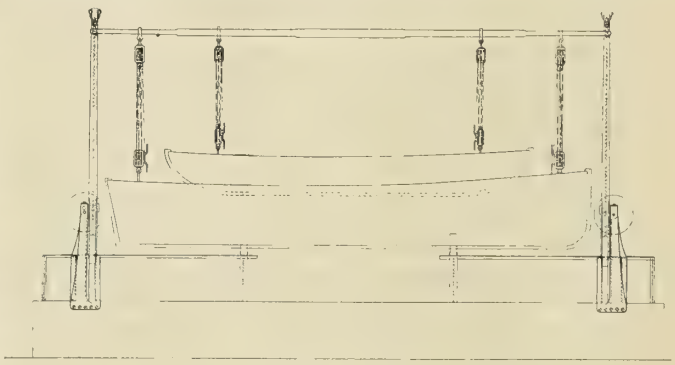


THE USE OF THE DAVITS WITH SHIP HEELED 8 DEGREES.

Reverting to the Welin quadrant davit, I first wish to emphasize one or two purely mechanical points of interest.

THE HORIZONTAL TRAVELING MOTION GIVEN TO THE DAVIT ARM.

The advantages of this arrangement in regard to leverage are apparent at first glance. Say that the distance between the keel lines of the boat in the two extreme positions is 10 feet,



TWO BOATS CARRIED ON ONE SET OF DAVITS.

and the travel of the moving fulcrum is 3 feet, the load lever when greatest is 30 percent less than would be the case with a davit turning on a fixed center, while the working lever (the radius of the quadrant) remains constant throughout the movement, or even increases, as shown in the arrangement for a battleship.

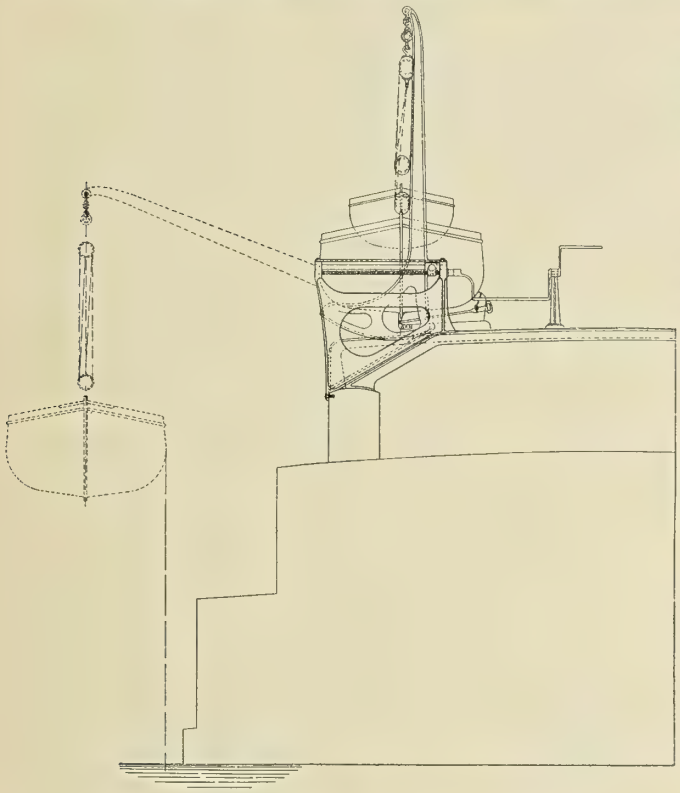
* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 22, 1907.

THE COMPENSATING ARRANGEMENT OF THE FALLS.

Instead of attaching the falls direct to a belaying pin on the davit proper, they are at first led over stationary sheaves, then belayed on the quadrant. The result is that the pull on the falls tends to raise the davits and, though it sounds like a paradox, part of the weight of the boat itself is thus utilized for lifting it inboard. The explanation is easy.

In hoisting the boat from the water it is lifted some distance higher relatively to the upper block than would be necessary if the falls were to be belayed direct on the belaying pin without first being run over the said sheaves, and then, as the davits are swung inboard, the boat drops back. The distance of this drop, multiplied by the weight of the boat, represents the assistance obtained in manipulating the handles, *e. g.*, if the weight of the boat is 30 cwts. and the drop 18 inches, the gain would be 2¼ foot tons, not deducting anything for additional friction and stiffness of ropes.

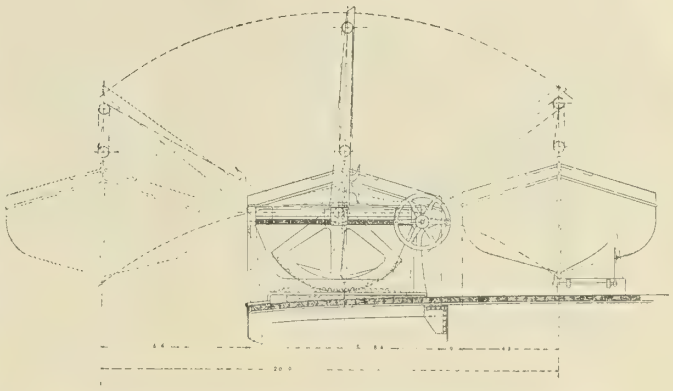
Generally speaking, the boats are placed at a distance from each other of about 5 feet, which is sufficient for the working



THE WELIN QUADRANT DAVIT APPLIED TO A BATTLESHIP.

of two single davits between the boats. A more compact and perhaps neater looking installation is that formed by double or twin davits between the boats. Some firms, however, object to the use of twin frames on the ground that only half the number of boats in each row can be swung out simultaneously. The objection, admittedly, holds good only in regard to boat drill, when, of course, it is more imposing to see all the boats going out precisely at the same moment. In actual use, the lowering of all the boats simultaneously into the water would, even under favorable circumstances, invite confusion and disaster. When the fitting of single frames is insisted upon, but the length of available deck does not admit of the boats being placed 5 feet apart, a distance piece is dropped over the handles to prevent these from fouling each other, or a special bevel gearing is fitted.

Occasional difficulties have arisen where an excessive outreach has been required. In simple cases where this has been caused merely by the adoption of a particularly wide belting

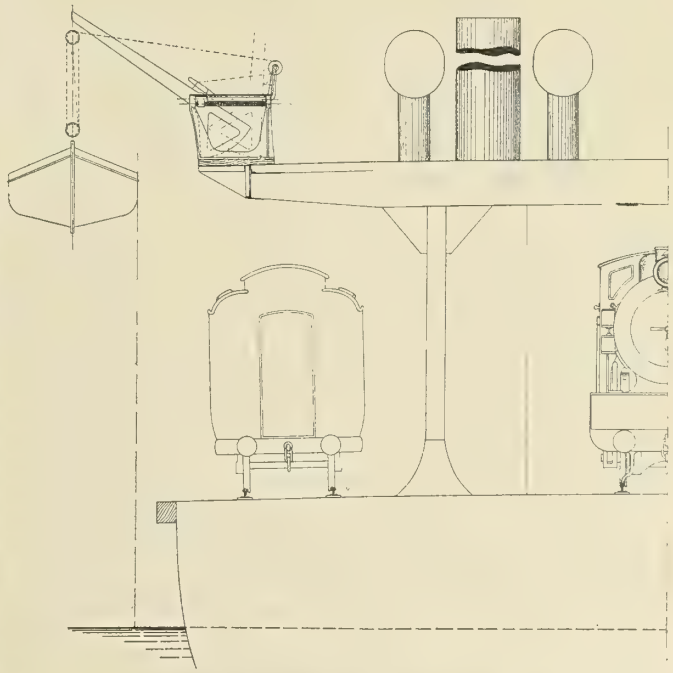


THE ARRANGEMENT OF THE DOUBLE DAVIT FOR TWO BOATS.

or rubbing strake, it has been surmounted by shifting the center pin of the quadrant relatively farther towards the back of same, and this, coupled with the throwing out of the outboard end of the frame a few inches, has, so far, proved equal to all demands. In the cases of battleships, however, where the boats are so frequently carried on lofty superstructures situated at some distance inboard, the problem has presented more features of interest, especially when the heavy weights of boats, usually carried in vessels of this class, be considered.

Increasing the length of the arm is not a practice which can be continued indefinitely, as, apart altogether from the resulting strains and stresses of the metal itself, there is a limit where the excessive labor consequent upon an increased leverage is such that a quadrant davit would offer little or no advantage over the present battleship arrangement for slinging out boats by means of derricks or similar appliances. The plan adopted to gain the end required, while retaining to the full the advantageous arrangement of the quadrant, has been arrived at by what may be termed differential radii being given to the quadrant, with the result that while the boat may be slung out with perfect ease, there is no especial difficulty attaching to bringing it home again, the greatest lever being available when most needed.

Whatever criticism you pass on the Welin quadrant davit as



THE DAVIT AS APPLIED TO A CAR-CARRYING FERRY.

a mechanical contrivance, I am bound to say that its adaptability to all kinds of arrangements of the boats has fairly astonished me. Here are a few examples:

A boat may be chocked half outboard, thereby saving for promenading purposes some 120 square feet of deck space in the case of each individual boat. These are as safe as when stowed inboard, and need only be swung in when the ship enters harbor. To do so requires a fraction of a minute.

The fact that the davit arm always remains in a locked position unless manipulated by means of the screw is one of the more important points about this system. I have included a scale diagram of a ship in section having a list of 8 degrees, wherein you may notice the boats in different positions. In connection herewith I can do no better than quote a few lines out of a testimonial from the North German Lloyd, based upon prolonged trials:

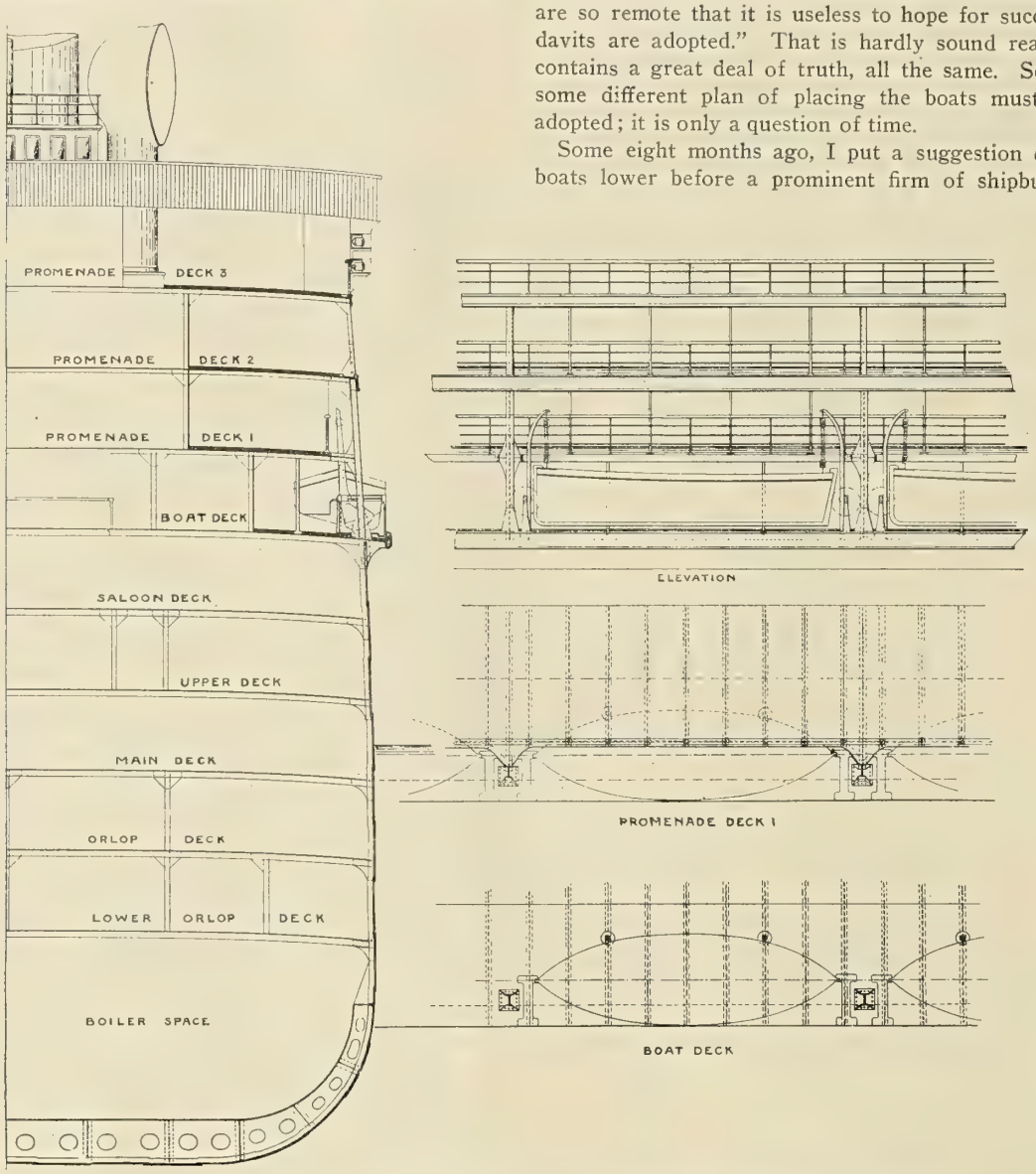
"With a list of 11 degrees of the ship the boat on the high side was put out in forty-five seconds. When the ship was rolling to a fair degree this was again done in one minute by four men, and the superiority of these davits, in so far that they remain stationary at any point without guying, then became apparent."

A row of boats placed abreast on the top of a deck house may be run out one after the other to the edge of the deck on either side, picked up and swung outboard by the davits. No other gear that I know of lends itself so admirably to a plan of this kind. In a modification of the davit itself, by which a double quadrant is used, a boat standing inboard of another may be picked up direct from its chocks and swung outboard.

Before concluding, I must take up a remark which has been put to me on more than one occasion—"What is the good of taking so much trouble over a question like this? The chances of ever getting any lifeboat safely into the sea from the tremendous height at which they are placed on present day liners are so remote that it is useless to hope for success, whatever davits are adopted." That is hardly sound reasoning, but it contains a great deal of truth, all the same. Sooner or later some different plan of placing the boats must and will be adopted; it is only a question of time.

Some eight months ago, I put a suggestion of placing the boats lower before a prominent firm of shipbuilders on the continent, without at the time obtaining any definite result. I am, of course, fully alive to the many difficulties in the way of getting some such scheme adopted, and it may require a few more of those disasters which stir humanity to its very core before conservatism can be made to budge.

Shipbuilders do not, as a rule, welcome deviations from orthodox designs; that such deviations, possibly resembling the one fore-shadowed above, must ultimately come, I am nevertheless more than ever confident. At a time when scarcely a month passes without witnessing the birth of some new leviathan, each exceeding its forerunner in speed and passenger-bearing capacity, the compelling necessity for such vessels to be fully equipped with life-saving appliances of the highest order is a fact which cannot fail to thrust itself with an



THE BOATS CARRIED ON A LOWER LEVEL THAN USUAL, TO FACILITATE HANDLING FROM A LARGE SHIP.

added force and conviction upon the observation of the most callous.

In bringing these remarks to a close, and speaking, as far as it is possible for me, from an impartial standpoint, I venture to assert that if ever there was a moment when the matter so briefly dealt with in this paper called for careful and renewed consideration, that moment is now, when the gigantic creations of recent months and the rumors of even greater things in the near future, bring to the whole subject a new significance.

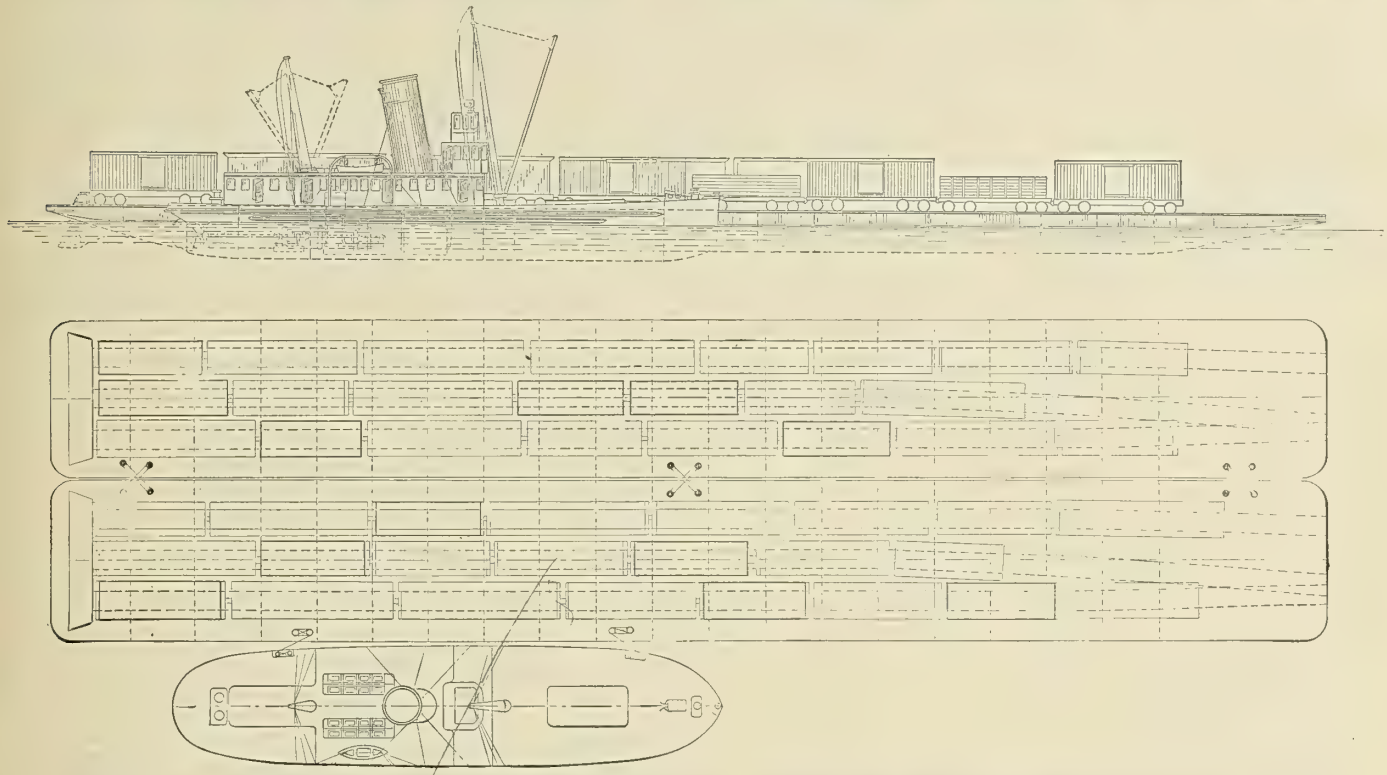


FIG. 5.—MARINE UNIT SYSTEM—POWER BOAT AND CAR FLOATS. ELECTRIC UNIT SYSTEM OF MARINE TRANSPORTATION.
Scale 1/48″ = 1 foot.

MODERN MARINE TRANSPORTATION—II.

BY WILLIAM T. DONNELLY.

DETAIL APPLICATION OF THE ELECTRIC UNIT SYSTEM.

In the discussion of marine transportation in its broadest sense, the first division must be made along the line of goods to be transported and the means used in transporting them, and as this paper is to deal mainly with a new application of power to marine transportaion, the discussion will be directed to the means used for transportation. This division embraces the floating structure or vessel to carry the goods, the crew for controlling the same, and the power used to move the vessel and crew from place to place.

That part of the problem represented by the crew involves the provision for their sustenance and living accommodation, and also such recompense for their service as will secure competency in the various branches. The division represented by the vessel involves all the problems of naval architecture, such as form, dimensions and materials of construction. The third division, that of power, involves all the mechanical construction, operation and control of the particular source of power which is to be used, and the fuel from which the power is obtained. It will be necessary to consider each of these divisions under further sub-divisions, as the investigation is carried more and more into detail.

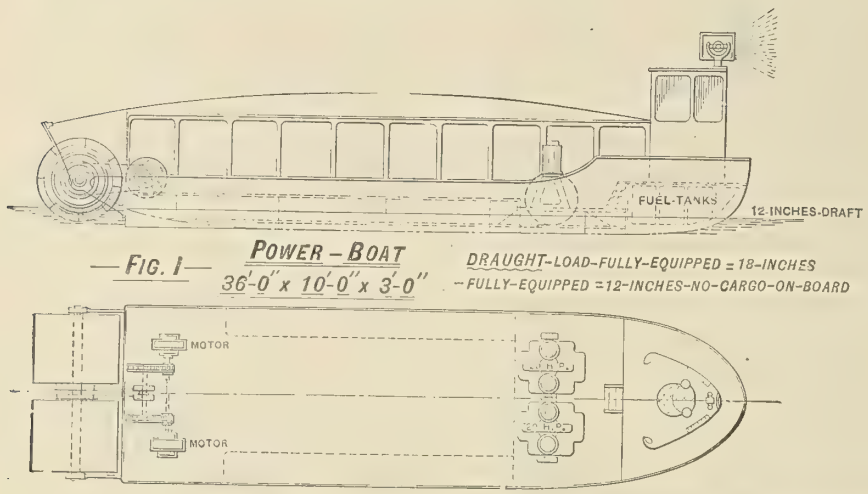
The first result of the application of steam power to marine transportation was to cause a primary division of the crew into a navigating and engineering corps. The development of steel as a structural material resulted in the division of the construction into two types—metal and wood. The continued growth in dimensions has resulted in almost eliminating the wooden type of construction. In the development of the power element two main factors have controlled, the dimension of the transportation unit and speed at which it was to be driven.

In classifying marine transportation units, the first division that is to be made is between those that are used for passenger transportation, and those that are to be used exclusively or primarily for transportation of merchandise. As this paper is to deal in detail with that class of marine units or vessels intended exclusively or primarily for the transportation of merchandise, little consideration will be given to the class in which the propelling power is necessarily so great as to almost exclude the consideration of other factors.

Marine merchandise carriers have again to be divided into classes, each of which is developed for the particular trade to which is to be applied; and the detailed discussion following will first be limited to marine transportation units designed and adapted for use in transporting merchandise in coastwise service for a distance of approximately 100 miles. Comparison will be made between a modern freight steamer of 2,000 tons cargo capacity on the one hand and a fleet of three barges with their power vessel, comprising an electrically operated marine transportation fleet, on the other.

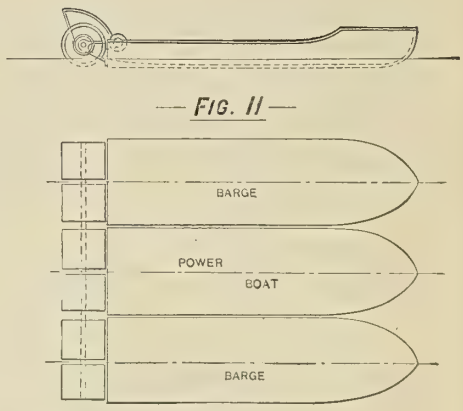
In the movement of freight a very important consideration is the rate of speed at which the movement is to take place. In this system, 10 miles an hour on water has been considered as a speed which would represent ordinary rail freight transportation, including the incidental delays due to yarding and switching, and final transfers upon car floats, which is considered part of the necessary handling of freight in coming and going from the large centers, such as New York, Philadelphia and Boston.

In Table I. are given the details of dimensions and cost in parallel columns of a freight steamer of 2,000 tons cargo capacity, and a combined unit, comprising a power boat and three



—Fig. I— **Power-Boat** 36'-0" x 10'-0" x 3'-0"

DRAUGHT-LOAD-FULLY-EQUIPPED = 18-INCHES
-FULLY-EQUIPPED = 12-INCHES-NO-CARGO-ON-BOARD



—Fig. II—

FIG. 6.—ELECTRIC UNIT SYSTEM WITH MINIMUM DRAFT AND MAXIMUM POWER APPLICATION.

TABLE I.

	Freighter	Combined Unit	
		Power Boat	Car Floats
Length	300'–0"	132'–0"	320'–0"
Breadth, molded	38'–0"	30'–0"	40'–0"
Depth, molded	23'–0"	13'–6"	10'–6"
Draft	14'–0"	7'–0"	6'–0"
Capacity in tons: Bunkers	50.	50.	
Capacity in tons: Stores, &c	20.	5.	
Capacity in tons: Freight	2,000		2,000
Weight of hull	1,150	315	1,200 (a)
Weight of machinery	180	185	40 (a)
Displacement	3,400	555	4,070
Indicated horsepower	1,700	1,400	
Speed, miles per hour	10	10	
I. h.p. per ton freight	0.85	0.7	
Hours operating per month	300	648	
Hours in port " "	420	72	
Mileage " "	3,000	6,480	
Freight capacity " "	60,000	129,600	
Ton-miles " "	6,000,000	12,960,000	
Freight rate per ton-mile	6 mills	6 mills	
Investment: Hull and Machinery	$312,000	$86,000	$129,000 (b) total, 215,000
Freight capacity per $100 investment	0.641 ton	0.93 ton	
Freight carrying capacity per month per $100 investment	19.24 tons	60.28 tons	
Cost per ton of freight carrying capacity	$156	$107.50	

a Two car floats. b Three car floats.

TABLE II.

Monthly Figures	Freighter	Combined Unit		
		Power Boat	Car Floats	Total
Interest on investment....5%	$1,300	$ 360	$537	$897
Depreciation.....3%	780	215	323	538
Pay-roll	1,800	1,025	300	1,325
Stewards' stores	400	280	.....	280
Coal	1,750	3,175	.....	3,175
Engine room stores	150	200	.....	200
Deck stores	50	100	.....	100
Total expenditures	$6,230	$5,355	$1,160	$6,515
Income	$36,000			$77,760
Earnings	29,770			71,245

car floats, each of which will have a net merchandise carrying capacity of 2,000 tons.

It will be seen from this table that the dimensions of the steamer will be—length 300 feet, breadth 38 feet, and draft 14 feet, and in the comparison, the first noticeable feature is the reduction of draft, it being entirely practical to reduce the draft of the power boat to 7 feet, and that of the car floats will be only 6 feet. It is at once apparent that this will extend the possible navigation over a much larger territory. It will be seen that the indicated horsepower for the fleet is slightly less than for the single vessel, this being occasioned by the much easier form of the car floats over the freight steamer of the dimensions given.

It is assumed that the freight boat will make one trip a day, or will operate 300 hours per month, while two of the car floats and the power boat will be in operation 90 percent of the time, or 648 hours per month. Under this schedule the steamer will make 3,000 miles per month, and the combined unit 6,480 miles, giving a monthly capacity for freight of 60,000 tons for the steamer, and 129,600 tons for the combined unit.

The freight rate is taken as 6 mills (1.2 farthings) per ton-mile. This is not an arbitrary rate, but one determined from the average of a number of years in the coastwise trade.

From carefully prepared figures the total investment for the hull and machinery of the freight steamer is placed at $312,000 (£64,112); that for the power boat at $86,000 (£17,672), and for three car floats, $129,000 (£26,508), or a total for the unit of $215,000 (£44,180).

It will be seen from the figures that for each $100 investment in the freight steamer, provision is made for carrying 0.641 ton of freight. In the combined unit, considering only two car floats to be in use at one time, for the same investment of $100, 0.93 ton is carried. The comparison of freight carrying capacity per month on an investment of $100 is 19.24 tons for the freight vessel, and 60.28 tons for the combined unit, or more than three times as much. Comparing the investment per ton of freight carrying capacity, that for the steamer is $156 (£32), and for the combined unit $107.50 (£22).

Referring to Table II., there will be seen a comparison of the operating expenses and revenue to be derived. The interest on the investment is taken as 5 percent in both cases, and the depreciation at 3 percent. The pay roll in each case has been made up by careful comparison and investigation of operating expenses on the Atlantic coast of the United States. The consumption of coal has been taken at 2 pounds per horsepower-hour, and at a cost of $3.50 (14/4½) per ton, the same in both cases.

It will be seen that the total expenditures monthly for the freight steamer will be $6,230 (£1,280), and for the combined unit, $6.515 (£1,339).

The income at 6 mills per ton-mile for six million ton-miles per month will amount to $36,000 (£7,398) for the freight steamer, and for the combined unit, with 12,960,000 ton-miles per month at the same price, will amount to $77,760 (£15,979), leaving a net monthly earning capacity, for the steamer, of $29,770 (£6,118), and for the combined unit, $71,245 (£14,640). From the monthly earnings, as stated, there would, of course, have to be deducted the ordinary and extraordinary repairs. While these items have been omitted to simplify comparison, it is confidently believed that they would be much less in the transportation unit than in the freight steamer.

Attention is called to the fact that an extra car float is provided, which would make it possible to repair the freight carriers without interfering with the business, while in the case of the steamer, any repair which would interfere with operation would at once eliminate all earning capacity.

It may be contended that this service is properly a tug-boat service; but it is submitted that in the bays and sounds of the coast, and near the mouths of large rivers, a great quantity of this class of transportation is carried on by steamers, under the conditions set forth, and that it is a well recognized fact that for a tug to handle two car floats of the dimensions given it would require to have a draft of not less than 14 feet, and even then it would be impossible for the tug to control the car floats in moderately heavy weather.

One of the greatest advantages of this system over the use of a tug lies in the greater facility in docking the floats; nearly all the float bridges are so located that a strong tide sweeps by, and great difficulty is experienced in properly making the slips. With this system the power boat, with its bow against the car float, would act as a tug to hold it against the swing of the tide, while the electrical power applied to the propellers of the float itself would move it across the tide into the slip.

Too much consideration cannot be given to the reduction of draft which is possible in the power boat over the tug. This would mean a great extension of the car float business, and enough has been said to make it clear that there is no other system by which freight can be handled for so little cost. It may be contended that it would not be possible to always have the freight cars loaded to their full capacity, for much light and bulky freight has to be carried. On the other hand, it is submitted that the freight rate for light and bulky articles is increased to the point where the revenue per car is practically the same amount. And it is further contended that great saving would result in wear and tear of heavily loaded cars, both to the cars themselves and to the railway's roadbed, by shipping all heavy machinery by car float lines.

It should further be pointed out that at the present time a very large percentage of the freight arriving at large centers of shipment, such as New York, Philadelphia, Boston and Baltimore, has necessarily to be run upon car floats for distribution, and often to load to and from cars alongside of steamers, and if it is a fact, as has been shown, that the cars upon the float can be moved at a rate of 10 miles per hour, at a cost very much less than upon railroads, it should be apparent that this branch of transportation will have a very great extension, if the power necessary to move the freight can be applied on as small a draft as 7 feet. This extension would make it possible for any and all railroads to have shipping facilities at great seaports for such commodities as can be handled direct between cars and vessels.

MECHANICAL AND ELECTRICAL EQUIPMENT OF TRANSPORTATION UNIT.

Referring to Fig. 4, which illustrates the power boat: This boat is designed to have a length over all of 132 feet, a breadth of 30 feet, a depth of 13 feet 6 inches, and a draft of 7 feet.

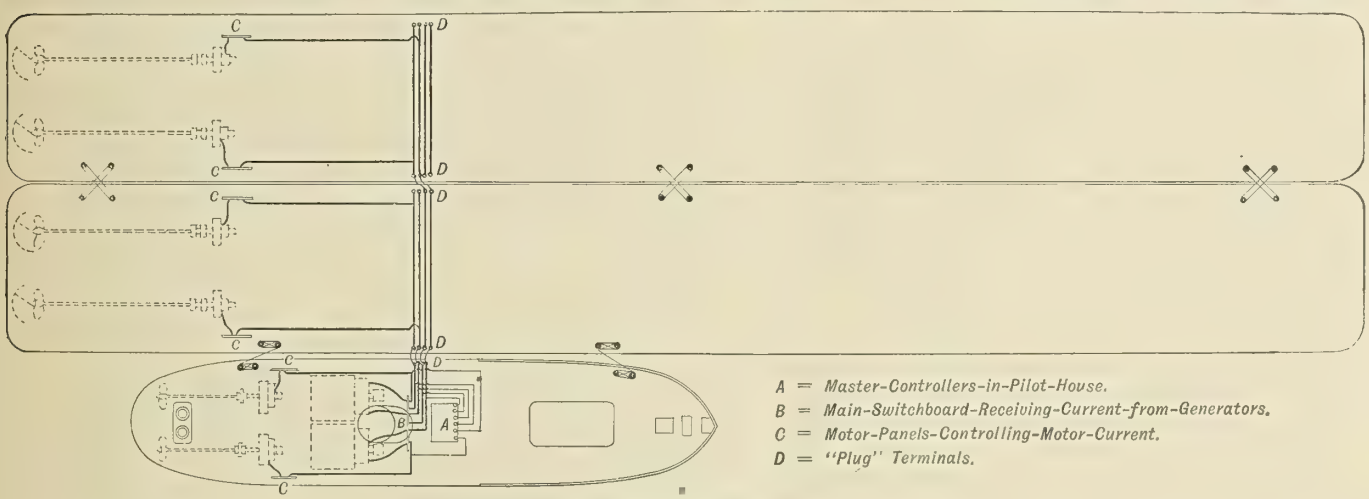


FIG. 7.—WIRING LAYOUT FOR POWER BOAT AND CAR FLOATS.

The boiler equipment comprises two Scotch marine boilers, each 12 feet in diameter by 11 feet 6 inches long, each to contain two Morison furnaces, and containing a total heating surface of 1,736 square feet, and a grate area of 48 square feet (36.2 to 1). The boilers are designed for 175 pounds working pressure, and will furnish steam to two vertical compound condensing, self-contained, inclosed Williams engines, with cylinders 15 and 26 inches in diameter by 21 inches stroke, operating at a normal speed of 220 revolutions per minute. This engine is guaranteed to develop a horsepower-hour on not to exceed 14 pounds of steam. The total weight of these engines, with extended base, shaft and flywheel complete, without generator, will be 74,000 pounds each.

Electric Generators.—These will consist of 500-kilowatt, compound-wound generators, over-compounded to maintain a constant voltage at the motors. The main switchboard will be installed, equipped with two main dynamo switches, six power feeder switches, and the usual circuit breakers, voltmeters, ammeters, ground detectors, etc. It is planned to use circuit-breakers in place of fuses on the motor circuits, as these can be automatically reset by moving the master controller to "stop" position. Auxiliary circuits will be provided for lighting, hoist motors and similar minor duties.

Electrical Transmission.—Each propeller will be driven by

a 200-horsepower, 500-volt compound-wound, variable speed, reversing, direct-current motor of interpole type, with wide range of field control.

Wiring Connections.—The wiring connections for the motors will be carried to controlling panels located close to the motors, and equipped with the latest electrical controlling devices automatically operated from a distance. This arrangement provides a minimum number of heavy conductors carried to the power boat. The system of wiring on the floats and power boat is shown in diagram on Fig. 7.

As the connections between the different vessels will be made by flexible multiple cables, the connections are indicated by single lines on the diagram. The connecting cables will be made long enough so that they may have sufficient slack to allow for such relative movement of the vessels as will be occasioned by rough water. Lashing of the vessels together by hawsers will prevent any mechanical strain coming on the electrical cables.

The use of multiple cables makes light the manual labor of connecting, so that the plugging in of a single cable is the only operation necessary for connecting any one motor. On account of the light strain between vessels with this system of propulsion, the lashing hawsers need not be so heavy as now used, so that this part of the work will be lighter, and will offset the time required to make the electrical connections.

Power Boat Switchboard.—On the power boat the main conductors will lead to the switchboard in the engine room, and the controlling wires will be carried to the pilot house, where they will be connected to master controllers of similar appearance to the familiar engine room telegraph. By moving the different levers the pilot will be enabled to run any motor in the fleet, in any direction and at any speed. Nor will there be any delay in the execution of his orders; the electric controllers at the motors will "stand by" with unceasing alertness, and will never be caught napping.

Marine Freight Carriers.—As a freight carrier for protected and inland waterways, probably no form is more highly developed than the car float. One of these floats of the dimensions given, i. e., 320 feet in length, 40 feet beam, 10 feet 6 inches deep, and 6 feet draft, will carry twenty-three freight cars, representing a total net freight-carrying capacity of 1,000 tons. When it is considered that this amount of freight can be removed at a car float bridge by a locomotive in ten minutes, and the float reloaded with another 1,000 tons within another ten minutes, a very great economy in handling is apparent. It is desired to call attention to the fact that a transshipping terminal for this kind of freight requires but a minimum draft, no wharves or warehouses, as the goods are always protected from the weather in cars, and is very inexpensive to build and maintain.

The structure of the hull of the car float is of the simplest form, and as the hold is not used for any purpose, no complication results from dividing it into various watertight compartments, rendering loss from collision highly improbable. It should also be pointed out that the draft of a car float does not increase with the size of the float or the number of cars carried, but remains practically constant, admitting of very great extensions to shallow-water navigation. Altogether, it would appear that the addition of propelling power to the present steel car float is all that is necessary to very greatly extend its use in the field of marine transportation.

The most remarkable part of this system is that all the apparatus, from the boilers to the electric controlling apparatus operated from the pilot house, is of standard make, and can be procured in the open market. No special apparatus of any kind is required. The cost of all mechanical equipment has been arrived at from actual figures supplied by the manufacturers of the apparatus.

The total cost of the power boat is $86,000 (£17,672), which represents about $61.50 (£12-12-6) per horsepower, on a basis of 1,400 horsepower. A central station plant on land for generating electrical power can be constructed and equipped, where the cost of real estate is not high, for $65 (£13-7-2) per horsepower. From this it is apparent that a floating station for generation of power will be on approximately the same basis of investment as a central station on land; but with the very great advantage of a trifling cost for distribution and connections, and little or no distribution losses, and the additional very great advantage that it will work at full load capacity, which is the condition of highest economy.

The cost of fuel for a floating power station will be, if anything, less than for a central station located upon the water front, as it is apparent that the floating power station can go to the large centers of fuel supply and receive its fuel with the least amount of handling.

Finally, it is desired to point out that in all transportation the vital consideration is the application of power, and that the value of all investments in railroads, cars, locomotives, steamships and other means of transportation depends solely upon the effect produced by the application of power. The second principle involved is, that the amount of revenue for any particular investment in equipment is entirely dependent upon the constant effective application of power to the means used for transportation. And third, that the amount of transportation which can be accomplished with any particular equipment is largely dependent upon the amount of power that can be economically applied to its movement.

While in the foregoing analysis and illustration modern marine boilers and vertical reciprocating engines have been used in the power producing plant, it is apparent that this particular source of power is not an essential. Turbine engines may be used, or the steam plant may be replaced by the gas producer and gas engine, or any form of internal combustion engine with oil as a fuel.

Electrically Equipped Shipbuilding Berths.

There has been installed at Palmer's yard, Jarrow, a system of overhead cableways upon which electrically operated trolleys run. These cableways are supported by carriages held by braced supports, 125 feet above the berth, which allows them to be traversed across the berth while the trolley itself runs longitudinally. All the motions of longitudinal and lateral hoisting in handling materials are accomplished by means of electric motors. The cable span is 490 feet.

John Brown & Company's yard at Clydebank is equipped with vertical derricks, 100 feet apart, capable of lifting a load of 5 tons to a height of 125 feet from the ground. The mast is a braced column with a length of 130 feet. It is square in section, having a side of 6 feet at the center and tapering toward the ends. The jibs are also of square section. Hoisting is accomplished by an electric motor of 35 horsepower, while the jib is slewed by a motor of 10 horsepower.

The Dalmuir dock of Beardmore & Son is supplied with overhead traveling cranes run on a large gantry, the two sides of which are braced together, and may be roofed over for protection from the weather. The side braces are also provided with side walking cranes which travel along them, working from any point. These are capable of handling loads of 5 tons at a radius of 30 feet. The traveling cranes have a span of 108 feet, a total travel of 750 feet along the berth, and are capable of lifting 15 tons to a height of 140 feet. Power for all of these operations is supplied by means of electric motors. In the storage yard of the same plant is a long electric cantilever crane for handling plates. This is carried on a gantry, and has a total travel of 240 feet and a clear lift of 22 feet above the rail.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

METHODS OF HEATING AVAILABLE.

The following methods of heating, which are in use on shore, are all available more or less for use on board ship, some of them, as will be explained, being more easily adapted under all conditions, and some of them again not being suitable for ships that knock about in a sea way, but being quite practicable for those which keep an even keel:

1. The open fireplace, or closed stove burning coal.
2. Pipes or apparatus in which hot water is circulated.
3. Pipes and apparatus into which steam is delivered.
4. Apparatus in which electric currents are employed.
5. Apparatus in which the air is warmed, humidified, and, if necessary, cooled.

The last form of apparatus, it will be noted, combines heating and ventilating, and on shore that is the latest development. Many of the large new buildings, such as hospitals, government and municipal buildings, stock exchanges, etc., are warmed and cooled, where necessary, entirely by means of the air current, which is taken hold of, cleaned, dried where necessary, warmed where necessary, moistened where necessary, and so on. The latest development of heating and ventilating on board ship, on the great ocean liners and in men-of-war, is on these lines.

The old fireplace and stove, though it still holds a large place in the warming of rooms on shore, has long been condemned as inefficient, because the larger portion of the heat liberated by the combustion of the coal passes up the chimney. It is not necessary to remind marine engineers that a coal fire will burn only with a draft, and that the products of combustion are carried up the chimney, necessary with all coal fires, and with it the larger portion of the heat liberated. A certain quantity of heat passes out into the room from the glowing fire, by radiation, but it does not heat the air of the room, because the air is almost transparent to heat rays. The rays of the sun pass through our atmosphere without heating it to anything like the extent to which they heat any object against which they impinge, and the same thing holds with heat rays from a fire. Rooms, cabins, saloons, etc., however, in which either open fire places or closed stoves are used, are appreciably heated after the fire has been burning for some time, unless they are subjected to cold air drafts, or unless the walls of the cabin, etc., are also the unprotected sides of the ship, and the heat is thus conducted away; because the heat rays emanating from the glowing fuel and striking upon the furniture of the room, the bulkheads, etc., heat them up, and they in turn heat the air with which they are in contact, convection currents being set up in the well known manner, and the whole room being thoroughly warmed.

Where closed stoves are employed, and particularly where a certain length of iron chimney connected with the stove is within the room to be warmed, the heating effect produced is considerably greater than with an open fireplace, because of the radiation from the stove itself, and from the pipe.

A somewhat interesting method of heating a cabin, which the writer remembers to have seen in his younger days, may be worth mentioning. In an old wooden frigate of the British Navy, in which he served, the commander had his cabin heated in cold climates, as when going around Cape Horn, by an 8-inch spherical shot, heated to redness and suspended from the deck above by an iron rod, screwed into the plug hole of the shot. The ship was armed partly with old 8-inch smooth bore guns firing spherical shot, and as these always had a plug, it was an easy matter for the armorer to screw into it an iron rod having a hook at the other end, for suspending from overhead. The result was very good. The commander's cabin was a fairly large one, and it was well warmed, but the process of heating was rather troublesome. The shot had to be heated in the galley fire.

For many ships, tramps for instance, sailing ships, and the numerous coasting vessels, barges, and so on, the coal stove with its chimney passing up through the deck will probably long remain the only method of heating, though some of the apparatus to be described later would be found very suitable for tramps, whalers, sealers, etc., and even for the five-masted sailing ships that are still in being.

THE SYSTEM OF HEATING BY HOT WATER.

This is the favorite system on shore, but so far it has not found much favor on board ship, because of the difficulty

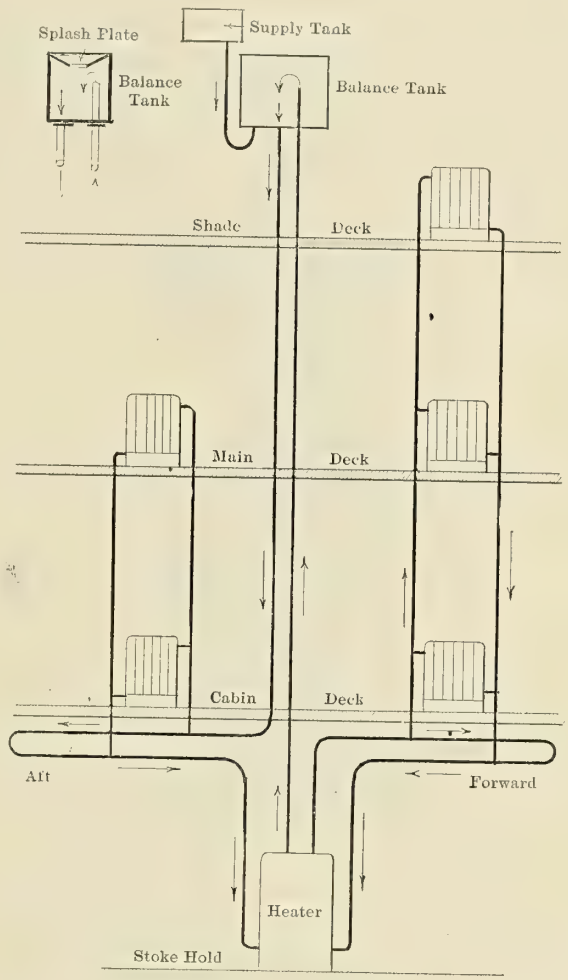


FIG. 3.—HOT-WATER HEATING SYSTEM APPLIED TO A YACHT. RADIATORS CONNECTED BETWEEN MAIN RISER AND RETURN; ALSO BETWEEN PIPE FROM BALANCE TANK AND THE RETURN.

mentioned above, introduced by the motion of the ship, straining different parts of the apparatus, and causing currents in the water with increased chances of air lock. Heating by hot water is a very simple matter. In its simplest form there is a boiler specially designed for heating water to a temperature of about 180 degrees F., and a system of pipes connected to the boiler in such a manner that the water is kept continually circulating from the hotter portion of the boiler through the pipes, and the radiators, as they are called, back to the boiler. An addition, however, is usually made to the system in the shape of a storage tank. Fig. 3 gives a diagram of the usual arrangement of hot-water heating systems, as applied on shore, and as it has been applied in certain cases on board ship. The diagram shown is taken from a hot-water system fitted on board a steam yacht.

The special boiler employed for heating the water may be displaced by steam from the boiler supplying the ship's engines, or from a special boiler arranged for the purpose, or the exhaust steam from the auxiliary engines may be used. Both of these plans are adopted on shore, the heat from the steam being delivered to the hot-water service by an apparatus which goes by the barbarous name of "calorifier," one form of which is shown in Fig. 4. This will be recognized by marine engineers as a feed-water heater. There is the usual cylinder, which may be fixed vertically or horizontally, with pipes inside in which the water to be heated circulates, steam passing all around them in the remaining space inside the cylinder. Or the reverse arrangement may rule, the steam may pass through pipes inside the cylinder, and the water occupy the space surrounding.

The calorifier has been arranged, in certain cases, with automatic steam control. Fig. 4 shows Royle's automatic steam control. A rod of steel is stretched between the top plate of the apparatus and the casting forming the bedplate, and is

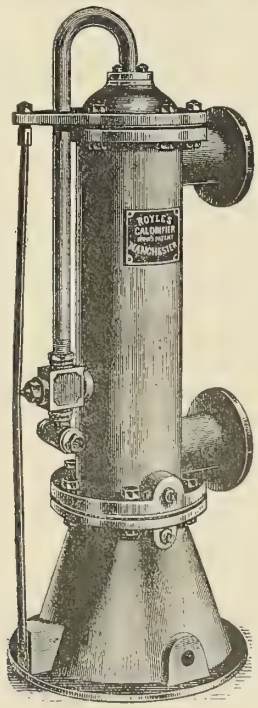


FIG. 4.—ROYLE CALORIFIER WITH AUTOMATIC CONTROL.

provided with a pair of nuts, enabling it to be tightened or loosened. A valve controlling the steam supply is fixed about the middle of the rod; as shown, the opening of the valve being controlled by a spring on the one hand, and the rod on the other. The expansion and contraction of the body of the apparatus, with the heat delivered to it, opens or closes the steam valve, by pushing against the head of the valve, or releasing it, thus increasing or decreasing the supply of steam. Another form of control consists of a bent tube, inclosed in a box, operating the steam valve in very much the same manner.

On shore, hot-water heating appliances are often combined with hot-water supply. This arrangement is very common in private houses, and also in hospitals, infirmaries, etc. When this arrangement rules in large establishments, it is usual to have a hot-water storage tank, in addition to the calorifier. The arrangement is as follows: Steam from the boiler supplies heat to the calorifier, the condensed steam being carried back to the hot well. The water pipes from the calorifier are connected to the storage tank, and the water is kept continually circulating through the storage tank, and through the calorifier. The supply of hot water for the establishment is taken from the storage tank. When very little water is used, the temperature of the water in the storage tank increases, and the controlling apparatus of the calorifier reduces the supply of steam, or completely shuts it off, until water is used again. When water is used, cold water, as will be explained, taking its place and the temperature in the storage tank being reduced, the temperature of the calorifier is also reduced and the steam is readmitted and so on.

High and Low-Pressure Hot-Water Heating.—There are two methods of heating by hot water, known, respectively, as high and low pressure. The main difference between the two is in the temperature to which the water is raised, and the velocity at which it circulates. In the high-pressure hot-water system, small pipes, usually of ⅞-inch bore, carry a small quantity of water at a high temperature and a high velocity, while in the low-pressure system larger pipes, from 1 to 6 inches bore, carry a larger quantity of water at a lower temperature and at a lower velocity. There is a further difference between the two systems also, in that the high-pressure system is hermetically sealed, an air vessel being provided to take up the expansion of the water mentioned below. In the low-pressure system a balance tank is usually provided, as shown in Fig. 3, which performs the double office of taking up the expansion of the water and supplying any waste that may take place.

DIFFICULTIES IN CONNECTION WITH HEATING BY WATER.

There are two principal difficulties to be encountered in heating by hot water, the expansion of the water itself, and the presence of air in the system. Water expands approximately 1/23 of its bulk between its point of greatest density (39 degrees F.) and its boiling point at standard barometric pressures. The following are the actual figures:

Temperature of the Water.	Relative Volume.
39° F.	1.
100° F.	1.0075
200° F.	1.038
212° F.	1.043
300° F.	1.086
400° F.	1.148
500° F.	1.223
600° F.	1.310

The expansion of the water must be provided for, and in the high-pressure system this is done by the expansion pipe, mentioned above, fixed at the highest point of the system and connected to it. The arrangement is merely a pipe calculated to accommodate a certain quantity of air, in proportion to the quantity of water in the system, and to the temperature of the water. The proportions recommended by Walter Jones, a past president of the Institution of Heating and Ventilating Engineers of Great Britain, are as follows:

With water at a temperature of 212 degrees F., the expansion pipe should have an air space equal to 1/20 of the water space in the whole apparatus. At 300 degrees F., the air space should be one-eighth of the water space. At 400 degrees, one-fifth; at 500 degrees, one-third, and at 600 degrees, one-half.

The operation of the expansion pipe is really that of a buffer. As the water expands it is forced upwards, and the air in the expansion pipe is compressed. If the expansion pipe and the whole of the system is sufficiently strong to withstand the pressure, and if the quantity of air in the expansion pipe is sufficient, when the water cools, the air expands, and equilibrium is maintained in the system and it works safely. The great danger of the high-pressure system is the possibility of explosion, owing to the very high pressures that are sometimes present. The expansion pipe, it will be seen, acts very much as a safety valve, in addition to its operation as a buffer.

With the low-pressure system there is no danger of explosion, except in case of frost in any part of the system, a

matter that will be dealt with below; because, as seen in Fig. 3, the expansion of the water is fully provided for by the balance tank. The increased volume of the water produced by the increased temperature merely flows into the balance tank harmlessly, and when the system cools, the balance tank re-supplies the water required to fill the pipes. The balance tank or auxiliary tank is usually connected to the water-supply service, to that any shortage of water in the system caused by leakage or evaporation is made up automatically. The balance tank should be fixed above the highest part of the pipe and radiator system.

THE AIR TROUBLE.

The air trouble is often a very serious one in both high and low-pressure hot-water systems, and it is the trouble that is likely to arise in connection with hot-water systems on board ship, and that is one reason, the writer believes, why hot-water heating has not been adopted. As marine engineers know, air is always present in water. It is lighter than water, and always finds its way to the highest part of the hot-water system, and if allowed to do so will come away harmlessly. On the other hand, if there are bends, particularly in the forms of inverted

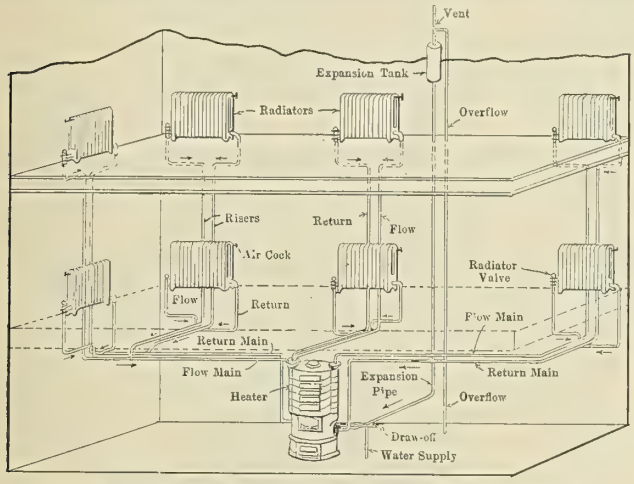


FIG. 5.—TWO-PIPE SYSTEM, LOW-PRESSURE HOT WATER.

U's, dips, etc., in the pipe system, air is sometimes trapped, and becoming compressed by the expansion and flow of the water, sometimes operates against the flow to such an extent as to even stop it altogether.

Engineers are all familiar with the troubles that arise with air when water is being pumped. In particular, the old trouble of the air lock in the bend of a siphon is well known; air, if allowed to collect in the bend, becoming gradually compressed and interrupting the flow of water. Something similar to this is of somewhat too frequent occurrence with hot-water systems, and it will easily be understood that when a ship is knocking about, and when currents are produced in the water circulation, quite independent of its circulation proper, and when possibly air may leak into the system through joints being strained, air locks may occur in certain parts of the system, with the result that the circulation of the water is interrupted, heating at the radiators ceases and dangerous heating may take place at the boiler or calorifier. The air locks are easily guarded against by the provision of air valves, which allow the air to escape under the conditions that have been named. It is usual on shore to place either small air pipes, or air valves, at the top of the system, and also at the tops of all bends, etc., and at each radiator, so that any air that is trapped may come away harmlessly.

THE ARRANGEMENT OF HOT-WATER HEATING SYSTEMS.

There are, broadly, two methods of arranging hot-water heating systems, both on the high-pressure and low-pressure working. It is necessary, as will easily be understood, for the water that is delivering heat to the rooms to be warmed, in order to make a complete circuit. Setting out from the hottest part of the boiler or calorifier it ascends through what is usually known as the riser or flow pipe, to the highest part of the system, and is connected to the balance tank above that, or to the expansion pipe, as explained. Another pipe rises from the coolest part of the boiler or calorifier to the same level as the riser, or a little below it. This is the return pipe, and in one method of distribution the heating appliances are connected between these two, very much as electric lamps are connected between the two supply cables, and as shown in Fig. 5.

The heated water passes from the boiler through the riser, through the different heating appliances, and returns to the boiler by the return pipe, becomes again heated in the boiler or calorifier, and repeats its journey. Where there are two or three floors or decks to be heated from the same apparatus, the different heating appliances are connected to the riser or flow pipe and to the return pipe of each floor or deck. One heating appliance may be connected between the flow and return, or two or more, according to the difference in temperature between the two, and to the sizes of the heating appliances and the quantity of heat required for them. Where a single heating appliance is connected between the flow and return it would correspond with the usual arrangement of incandescent electric lamps connected in parallel. Where two or more heating appliances are connected between the flow and return, in such a manner that the water flows through them consecutively, the arrangement would correspond to the parallel series arrangement of incandescent electric lamps.

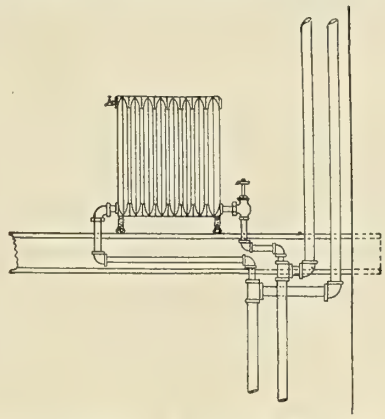


FIG. 6.—CONNECTIONS OF RADIATOR TO A HOT-WATER SYSTEM WITH TWO-PIPE DISTRIBUTION.

There is a third arrangement, corresponding roughly to the series system adopted in electricity, as with a number of arc lamps employed in street lighting, from a Brush arc machine. In this system the flow pipe is taken to the highest part of the service, say to the highest deck, or a little above, if possible, in the funnel casing, and is there connected to the balance tank or the expansion pipe in the usual way; but the two connections to the heating appliance are made to two portions of the return main pipe, as shown, the heating appliance being bridged across that portion of the pipe. This corresponds to the method known in electrical work as shunting.

Fig. 7 is a diagram of a number of radiators fed on the one-pipe system, the radiators being bridged across a certain length of pipe, but, as will be noticed, two radiators are fed from one bridge, and in this case the connection to the balance tank is separate. Fig. 6 shows the connections between a single radiator and the two pipes on this system. Fig. 8 is a diagram of a system in which the exhaust from a gas engine is used to heat the water, which is carried to a tank above the highest radiator, connection being made from the hot-water tank to the balance tank above; and the distributing pipes

commencing from the hot-water tank and returning to the water-jacket of the engine, and thence to the heating apparatus, the radiators being bridged singly across short lengths of the pipe. Practically, with this method, the heating appliance is fed by a shunt current from the return supply main of the service.

It will be understood that what is required for the supply of any heating appliance is a sufficient difference of tempera-

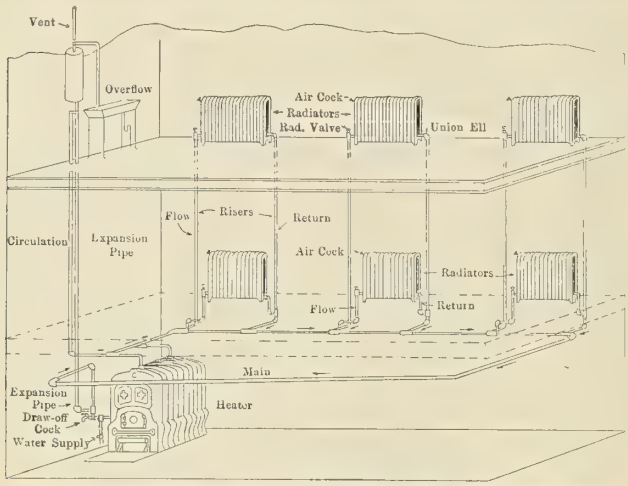


FIG. 7.—DISTRIBUTION OF LOW-PRESSURE HOT WATER ON THE ONE-PIPE SYSTEM.

ture between the inlet and outlet valves, and a sufficient supply of water to keep up a continual flow through it, and of such a temperature that the requisite quantity of heat will be given off by it. In practical hot-water heating, the difference of temperature between the two ends of any radiator is usually not more than 10 degrees F., and it is evident that this can be obtained either by having a very small difference of temperature between the main flow pipe and the return flow pipe, but with comparatively large pipes, bridging the heating ap-

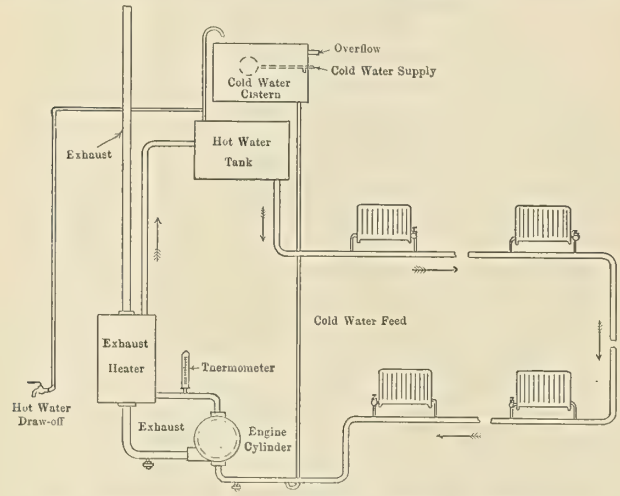


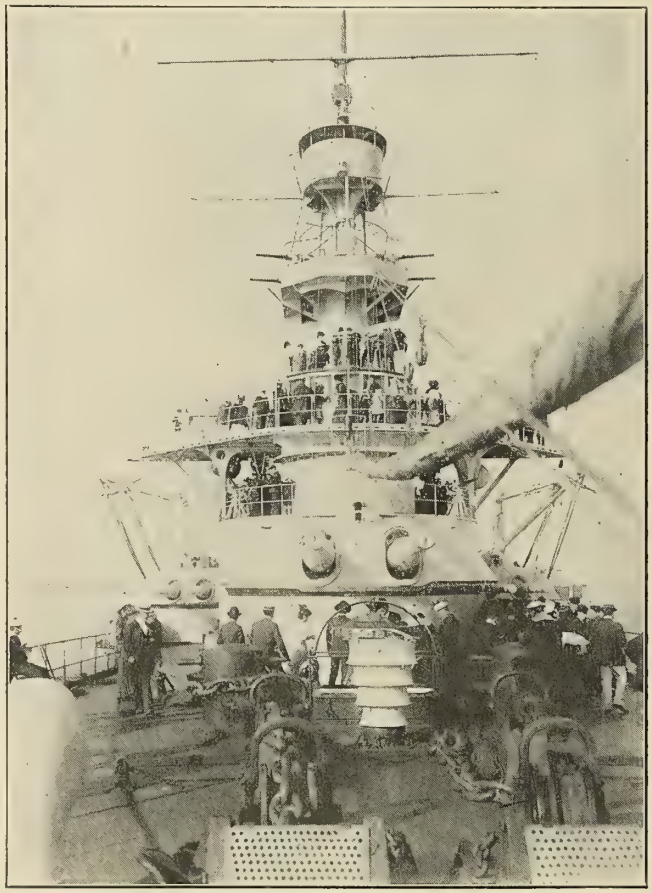
FIG. 8.—DIAGRAM OF A HOT-WATER SYSTEM DRAWING HEAT FROM THE EXHAUST OF A GAS ENGINE. (BRITISH INSTITUTION OF HEATING AND VENTILATING ENGINEERS.)

pliance between the two pipes, as explained; or by having a larger difference of temperature between the ends of the flow pipe and return pipe at the source of heat, with smaller pipes, and a smaller quantity of water flowing, but with a larger difference of temperature in any given length of pipe.

To take an instance, supposing that ten radiators are to be supplied from a given source of heat, and that each radiator requires a difference of temperature between its inlet and outlet valves of 10 degrees, as explained, and a flow of ten gallons of water through it per hour. Evidently this can be supplied by a system of large pipes, giving 100 gallons per hour, but with a difference of temperature between the main flow and return pipes of only 11 or 12 degrees F. at the source, or it can be supplied by pipes carrying only 10 gallons per hour, but with a difference of temperature between the main flow and return pipes, at the source of heat, of 110 to 120 degrees F. Practical men on shore incline very much to the latter system, because it enables smaller pipes to be employed, and they caution engineers to avoid the former system, because the water tends to become "short circuited"; that is to say, the nearer radiators receive the major portion of the heat. Evidently the matter is only one of proper arrangement.

It should be perfectly practicable, by a proper system of pipes, to arrange that the difference of temperature between the main flow and return at the top of the system shall be very nearly the same as that between them at the lower portions of the system. What is required, of course, is proper proportion in the size of the main and return pipes, and proper proportion in the pipes connecting them to the radiators. If the main flow and return pipes are small, and if again the radiators on the lower decks are connected to them by comparatively large pipes, they will undoubtedly short circuit the system.

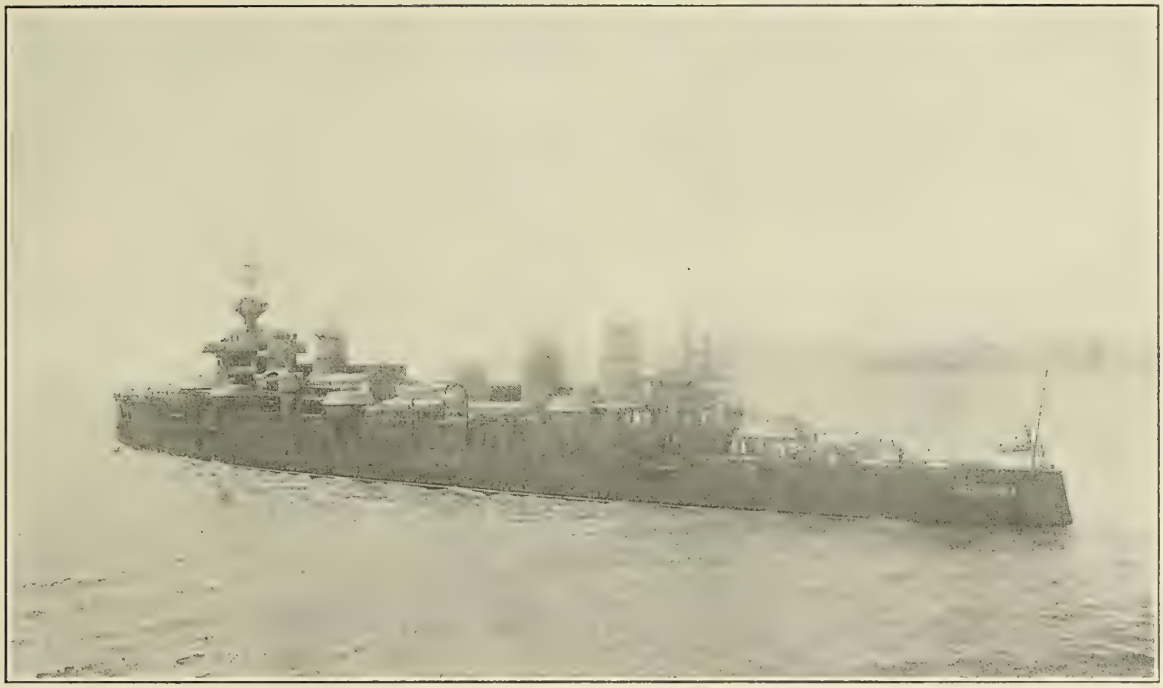
(To be Continued.)



THE FORWARD TURRETS OF THE ARMORED CRUISER VICTOR HUGO.

Trials of Armored Cruiser Victor Hugo.

This cruiser, which recently paid a visit to New York harbor, underwent her official trials early in the summer. She is a sister of the *Léon Gambetta,* illustrated and described at some length in our issue for April, 1906, the *Jules Ferry,* the trial trip of which was noted in our September, 1906, number, and the *Jules Michelet.* Each of these vessels has a length between perpendiculars of 486 feet 9 inches, an extreme beam of 70 feet 3 inches, a mean draft of 26 feet 7 inches, and a



THE FRENCH ARMORED CRUISER VICTOR HUGO.

displacement of 12,606 tons. The draft fully loaded is 27 feet 11 inches, under which condition the bunkers contain 2,200 tons of coal and liquid fuel. The normal coal supply is 1,400 tons.

The battery consists of four 7.6-inch guns, mounted in pairs in turrets forward and aft; twelve 6.4-inch guns, likewise in pairs in turrets, and four more of this size in casemates. In addition, there are twenty-two 3-pounders and two 18-inch torpedo tubes. The turret armor for the heavier guns has a maximum thickness of 8 inches, and 5½ inches for the 6.4-inch guns. The casemates have armor 4.72 inches, with top and bottom plates 1 and 1.2 inches, respectively.

There are twenty-eight Belleville boilers, discharging their products of combustion into four funnels 69 feet high. The boilers are distributed in eight boiler rooms, and contain a total of 1,660 square feet of grate and 55,830 square feet of heating surface, the ratio being 33.6 to 1. The three screws are actuated each by a four-cylinder triple-expansion engine with pistons 39, 59, 65 and 65 inches in diameter, and a stroke of 37 inches, the revolutions being 125 per minute.

The full speed three-hour trial with all boilers at work gave 28,426 horsepower and 22.55 knots as an average, the maximum being 29,048 horsepower and 23.12 knots. This compares with 27,500 horsepower and 22 knots in the contract, and with 29,008 horsepower and 23.06 knots in the trial trip of the *Léon Gambetta*.

The 24-hour coal consumption trial at 16,000 horsepower called for a consumption per horsepower-hour of not more than 1.875 pounds of coal. The actual consumption with 16.911

DECK OF THE ARMORED CRUISER VICTOR HUGO: VIEW LOOKING AFT FROM THE NAVIGATING BRIDGE.

horsepower and a speed of 19 knots was only 1.45 pounds. This compares with 1.68 pounds in the *Gambetta* at a speed of 20.37 knots.

The low-power consumption trial of 6 hours with four boilers only at work showed 2,500 horsepower with a speed of 10.3 knots. The consumption here per horsepower-hour was 1.435 pounds, as compared with 1.875 permitted under contract.

J. Peltier.

SOME EXPERIMENTS ON THE EFFECT OF LONGITUDINAL DISTRIBUTION OF DISPLACEMENT UPON RESISTANCE.*

BY PROFESSOR HERBERT C. SADLER.

During the past year a partial investigation on the subject of this paper has been conducted in the experimental tank of the University of Michigan; and although the results hereby submitted apply only to one type of vessel of a given ratio of beam to length, they may prove of interest and value. Further experiments are being conducted upon models of finer and fuller types, the results of which will be submitted at a later date. All the models were run at three different drafts and on an even keel. The three drafts represent about the limits at which the particular form would be run in general service, *i. e.*, from the ballast to the loaded condition.

TABLE OF PARTICULARS.

$\frac{L}{B}$	$\frac{B}{D}$	$\frac{L}{D}$	Coefficients.		
			Block.	Prism.	Midship.
8	3.0	24.	.697	.734	.949
8	2.5	20.	.715	.747	.956
8	2.143	17.143	.733	.760	964

The object of the investigation was to determine the effect of distribution of displacement only. With this end in view, the length, breadth, drafts, coefficients of form and hence displacement, were kept constant throughout the series. A set of lines representing one of the existing transatlantic intermediate type was taken as a basis or mean form, and the longitudinal distribution of displacement varied as shown in Fig. 1. In general the two extreme forms represent: First, a vessel with 40 percent parallel middle body, and hence rather fine ends; and, second, a vessel with no middle body and rather fuller ends, the midship section being the same for all types. The form with the fine bow and stern is marked 1, or rather 1B, 1S, and the full bow and stern 3, or 3B, 3S, the middle form being marked 2.

The curves of sectional areas are plotted as percentage curves in all cases with the area of the midship section as 100. The body plans of the two extreme types are shown in Fig. 2. It may be remarked that none of the forms is particularly extreme or beyond the pale of practicability.

In order to eliminate as far as possible any variation in general shape of section at the ends, the ordinates of each section were proportioned from the type vessel. For example, the area of section 2 for form 3 from the curve of sectional areas is approximately 1.10 times that of the same section for form 2. The ordinates of section 2, form 2, were therefore increased by this amount, and similarly for the other sections.

In all, five different models were made as follows: 1 bow, 1 stern (1B, 1S); 1 bow, 3 stern (1B, 3S); 2 bow, 2 stern (2B, 2S); 3 bow, 1 stern (3B, 1S), 3 bow, 3 stern (3B, 3S). The combination of fine and full ends gives some idea of the relative importance of the bow and stern in each case.

All models were run at speeds ranging from a speed-length ratio $V/\sqrt{L}$, of about 0.2 up to 0.8, and in the case of the lighter draft, 0.9 or over; it may be remarked, however, that vessels of this particular form would hardly be run at a higher speed-length ratio than 0.75 in actual practice, and certainly not lower than 0.60. The results of the experiments for the medium draft are shown in Fig. 3. The surface friction has been deducted and the curves represent the residuary resistance only, or rather the ratio of residuary resistance to displacement, in pounds per ton (2 240 pounds). They are plotted on a speed-length ratio base, *i. e.*, the abscissæ represents $\frac{V}{\sqrt{L}}$ where V is the speed in knots and L is the length in feet. The results are therefore independent of absolute dimensions.

An examination of the above curves develops some rather interesting features. In the first place, the general character of the curve of wave-making resistance is the same for each particular model at the different drafts. In general the model with the long middle body and fine ends has a more "wavy" character than that where the ends are fuller with a gradual increase to the midship section. The resistance curve for the model with the fine bow and full stern has somewhat the character of the two extremes, with the result that the curve becomes somewhat flatter than that for the two fine ends.

Froude has shown from experiments upon the effect of increasing the length of parallel middle body, but keeping the ends constant, that these points of maximum and minimum resistance correspond to the cases where the hollow or crest of the transverse wave system occurs at about the middle of the after body. The same appears to be true in the case of the vessel with the fine ends and long middle body, and the reason that the transverse system is more pronounced in this case, as compared with the model with full ends, seems to be that the somewhat abrupt change of curvature at the point where the middle body stops, causes an additional wave crest at this point. The same is true, though to a less extent, at the after end of the middle body, so that on the whole, instead of the bow system of transverse waves dying away gradually from the bow, there are two points situated at about 30 percent of the length from each end, where it receives, as it were, a fresh impetus. If, however, the after body from the midship section be replaced by the gradual form with the fuller end (1B 3S) the transverse system becomes much flatter in the after body, and hence, until high speeds are reached the height of the wave crest or hollow, occurring at the middle of the after body, is too small to have any appreciable effect. The above will explain the somewhat high resistance which the form with the fine ends experiences at the low speed-length ratios, as compared with that where the ends are fuller; and also may help to explain the fact that the form with the fine bow and fuller stern (1B 3S) is easier to drive than that where both ends are fine (1B 1S).

In comparing the two forms of bow, the influence of the fine lines forward as compared with the more rounded and fuller ones is most marked. The sharp angle of the forward waterlines reduces the wave making considerably, the fuller form tending to pile up a much more pronounced system at the bow. Taking the two extreme cases, *i. e.*, the best and the worst form, 1B 3S and 3B 3S, the comparative wave-making resistance at about the practical speeds for the particular type of vessel are as follows:

COMPARATIVE WAVE-MAKING RESISTANCE.

$\frac{V}{\sqrt{L}}$	Light Draft.	Medium Draft.	Deep Draft.
0.6	1.0 : 1.448	1.0 : 1.24	1.0 : 1.457
0.65	1.0 : 1.715	1.0 : 1.57	1.0 : 1.545
0.7	1.0 : 2.150	1.0 : 1.945	1.0 : 1.75
0.75	1.0 : 2.130	1.0 : 1.925	1.0 : 1.68

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 21, 1907.

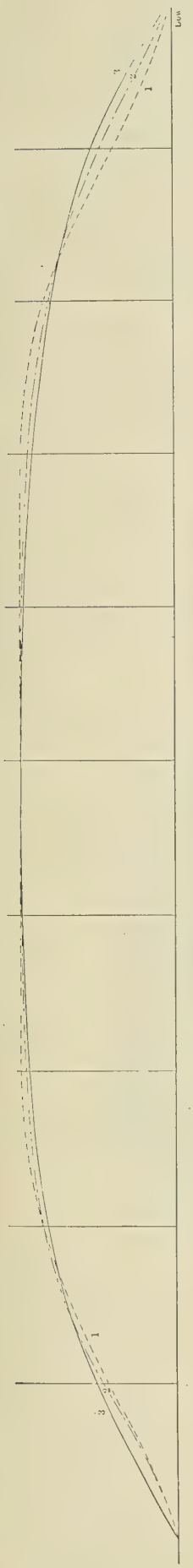
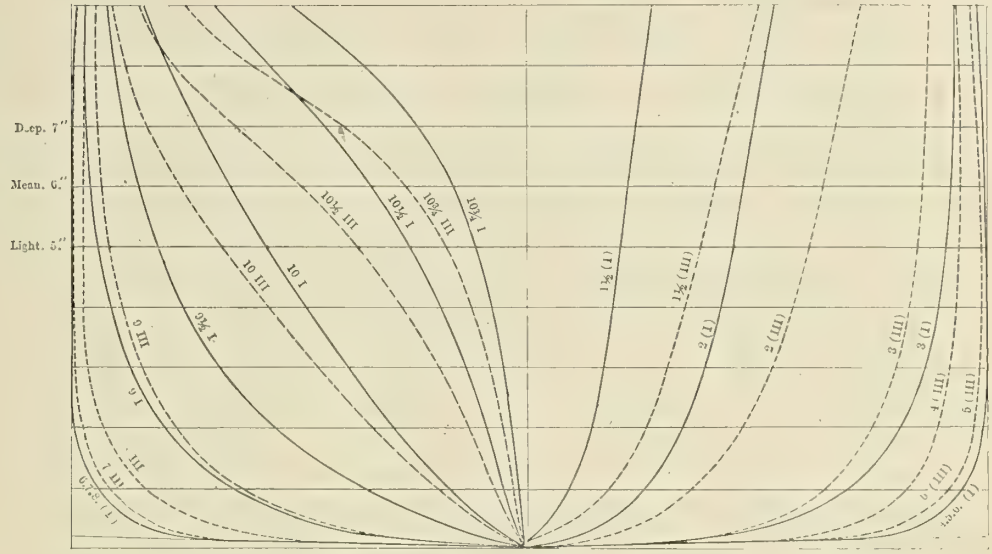


FIG. 1.—SECTIONAL AREAS AT FULL DRAFT OF THE THREE MODELS TESTED.



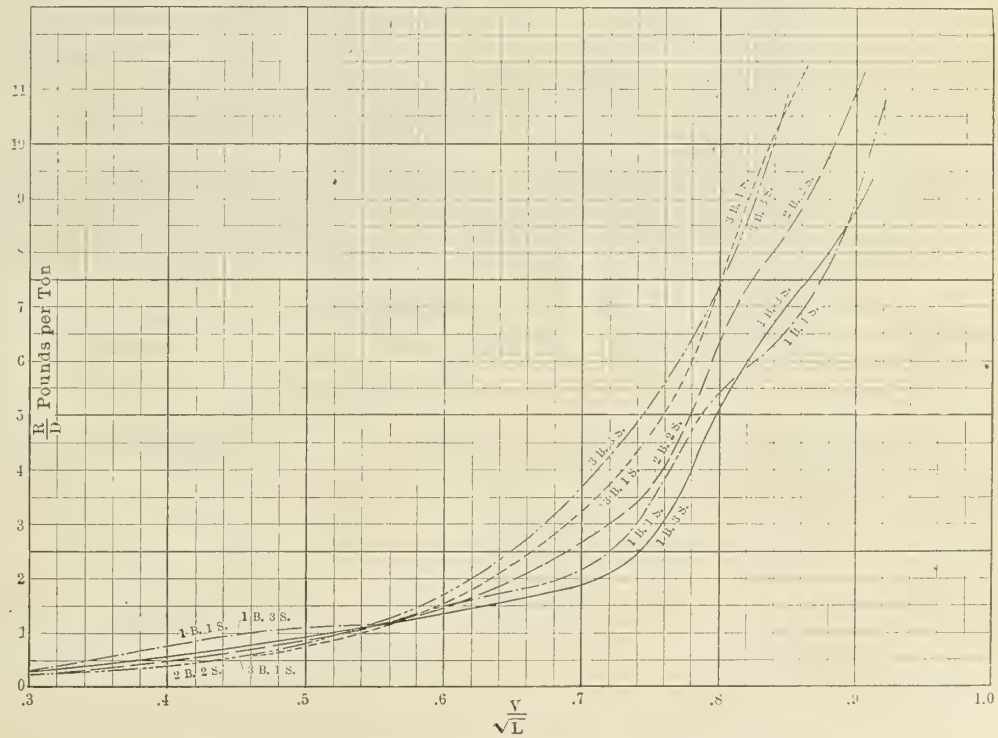
BODY PLANS OF FORMS I AND III, ILLUSTRATING LONGITUDINAL DISTRIBUTION OF DISPLACEMENT.

COMPARATIVE TOTAL RESISTANCES.

$\frac{V}{\sqrt{L}}$	Light Draft.	Medium Draft.	Deep Draft.
0.6	1.0 : 1.075	1.0 : 1.053	1.0 : 1.055
0.65	1.0 : 1.16	1.0 : 1.14	1.0 : 1.13
0.7	1.0 : 1.26	1.0 : 1.222	1.0 : 1.20
0.75	1.0 : 1.305	1.0 : 1.262	1.0 : 1.20

From the above table it will be seen that between the best and worst form there is a difference in wave-making resistance of nearly 100 percent at about the normal speed for the type of vessel, and a difference in total resistance of from 20 to 30 percent.

At the low speed-length ratios, the more gradual forms seem to give the best results, with the result that the mean form (No. 2) shows the smallest resistance up to a speed-length ratio of about 0.5. This is doubtless due to the easing away



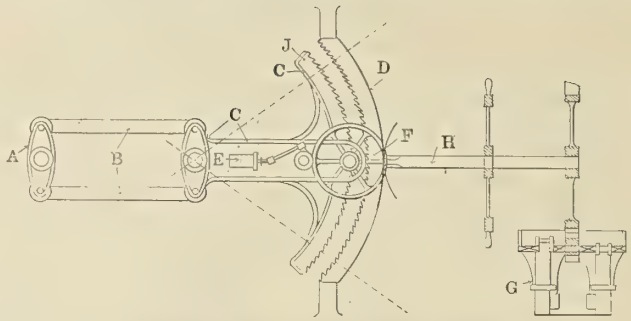
RESISTANCE CURVES OF FIVE MODELS AT THE MEDIUM DRAFT.

of the somewhat abrupt shoulder that occurs on the No. 1 forms. When, however, the higher speeds are reached, the influence of the finer bow becomes at once manifest. It should be borne in mind, however, that if a vessel were to be driven at a maximum speed-length ratio of from 0.6 to 0.65, the form adopted would be considerably fuller as a rule than that of the present series.

It is interesting to note that no matter what distribution of form is used in this particular type, when a speed-length ratio of anything over 0.7 is desired the resistance is increasing very rapidly. In fact, the limit of economical speed for this type seems to be about 0.725.

The forms with the full bows have a much more pronounced bow wave, the crest appearing practically at the bow. The system, however, has largely dissipated before reaching the stern, and there is no very pronounced wave in the after body, no matter what form of stern is used.

Although it is not safe to draw general conclusions, the results of the above experiments for this particular form may be summarized briefly as follows: With a given set of dimensions, length, breadth, draft and with a given displacement, it is advantageous, so far as the forebody is concerned, to use a comparatively long middle body and fine bow. In the after body, however, better results seem to be obtained by adopting a form with a more gradual diminution of area from the midship section aft. The action of the propeller should not be lost sight of in the design of the after body, but in the series under discussion it will be noticed that the form of the after body and shape of the waterlines give a fairly easy form, even in the case of the fullest shape.

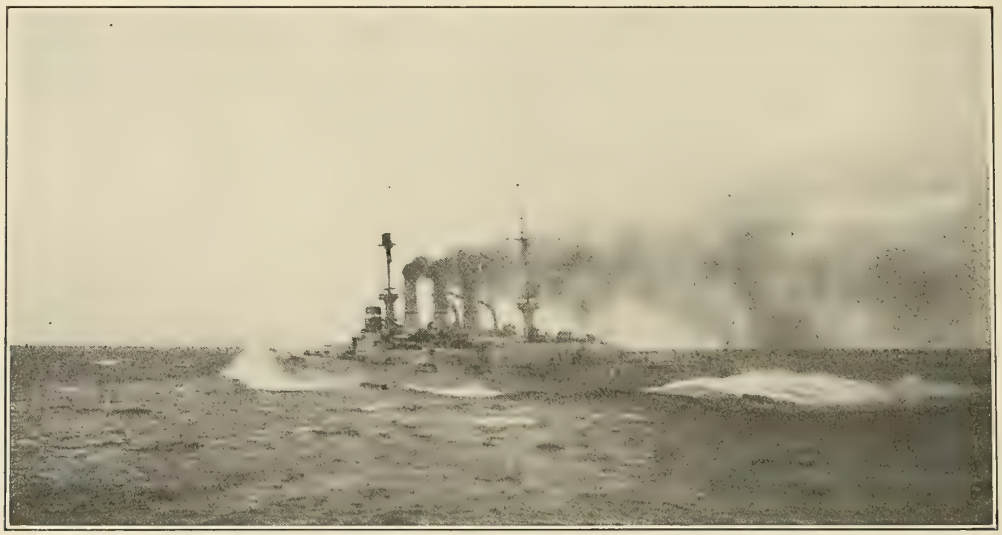


STEERING GEAR OF THE PRINZESS ALICE.

same connecting by two pipes with another cylinder in the steering engine room, where it operates the controlling valve of whichever engine may be running.

The operation is differential and reciprocal, *i. e.*, the movement of the rudder is automatically proportional to the movement of the wheel, and if the rudder be moved from the steering engine room, or some other part of the ship, or by the sea, the wheel will move also. In other words, the quartermaster "feels" his rudder and its movements very much as if the ship were a small yacht; which, as any seaman knows, is of greatest assistance in rough weather or in holding a close course in a heavy swell.

A less important and more common detail is the placing of all this gear rather forward on a false tiller *C*, where the ship is more roomy and stiffer, the false tiller being connected with the tiller *A* by two parallel heavy links *B* in a well-known manner.



THE GERMAN BATTLESHIP POMMERN ON TRIAL TRIP, AUGUST 24, 1907.

Steering Gear of the Prinzess Alice.

This gear is of peculiar interest because of its novel design and excellent features. Its two main features are independent spare power and a practically certain control from the bridge that absorbs very little power.

On the tiller is a twin steam engine *E*, which operates through a train of gears on a stationary rack *D*, thus swinging the tiller in either direction. Also on the tiller is a moving rack *J*, by which a separate or spare engine *G* operates the tiller through the shaft *H* and the spur wheel *F*. This gives a very compact and reliable arrangement; but the usual objection of a steering gear placed aft applies, *i. e.*, the control from the bridge, if electric is not perfectly reliable, if mechanical, is laborious and slow. In this case, the wheel on the bridge operates a piston in a cylinder full of glycerine,

It is impressive to marine men to note the ease with which this gear works, the silence, even when traveling hard over, and the absence of groaning ropes, etc. Instead of the usual stops, which break up gear and steering engines when putting her hard over, the engine merely runs off the rack, and the rudder strikes a bumper. The engine is provided with a governor, set to prevent excess speed. These, it is believed, form some unique features in steering machinery.

The ship, which belongs to the North German Lloyd Company, measures 523 feet 5 inches in length by 60 feet 1 inch beam and 34 feet 7 inches depth. Her net tonnage is 6,721 and gross tonnage 10,911. She was built by the Aktien Gesellschaft Vulkan, at Stettin, in 1900. Propulsion is by twin screws, operated by quadruple expansion engines with cylinders 27½, 40, 57½ and 82 inches, and a stroke of 55 inches.

The Trials of the German Battleship Pommern.

This ship, which was launched in December, 1905, is one of the *Deutschland* type, with a displacement of 13,000 tons, and designed for a speed of 18 knots, with 16,000 horsepower applied to three screws. The length between perpendiculars is 398 feet 6 inches, with a beam of 72 feet 10 inches, and a draft of 25 feet. Provision is made for the carrying of 700 tons of coal at a normal displacement, which may be increased to 1,600 tons with bunkers full, besides which 200 tons of oil may be carried.

The military features include a battery of four 40-caliber 11-inch guns mounted in pairs in turrets on the center line, forward and aft; fourteen 40-caliber 6.7-inch rapid firing guns; twenty-two 3.4-inch guns; fourteen 1-pounders; four machine guns, and six submerged torpedo tubes. The armor belt has a maximum thickness at the waterline of 9.45 inches, decreased to 3.94 inches at bow and stern. The heavy guns are protected by 11 inches of armor, and the lighter primary guns by armor from 5.9 to 7.87 inches in thickness.

In a 6-hour forced draft trial Sept. 13 a speed of about nineteen knots was obtained, the horsepower being 18,697, with 118 revolutions per minute, an air pressure of 0.9 inch, and a coal consumption per indicated horsepower per hour of 1.61 pounds. The next day a maximum speed of 19.26 knots was reached at 122.8 revolutions per minute, and 20,348 horsepower (Admirality coefficient 194). On Sept. 17 a 24-hour trial was run, in which the center screw was allowed to run idle, propulsion being by means of the two side screws. With 3,464 horsepower, the speed was 10.88 knots (Admirality coefficient 205.5), while the coal consumption was 1.59 pounds per horsepower-hour.

Our photographs are snapshots taken by a Glasgow reader, on the occasion of a preliminary trial, Aug. 24, 1907.

where in the neighborhood of 30,000, giving an estimated sea speed of 20 knots. It is reported that a swimming tank, 25 by 75 feet, and a tennis court are to be provided.

The principal dimensions of this ship show a length over all of 804 feet, a length between perpendiculars of 758 feet, a beam of 88 feet, and a depth to the upper deck of 63 feet 9 inches. It will be noted that the length over all exceeds that of the *Lusitania* and *Mauretania* by about 15 feet; the length between perpendiculars is 2 feet short of the Cunarders; the beam is the same, and the depth is more than 3 feet greater. The ship has thirteen watertight bulkheads and five complete decks in the hull, running from bow to stern.

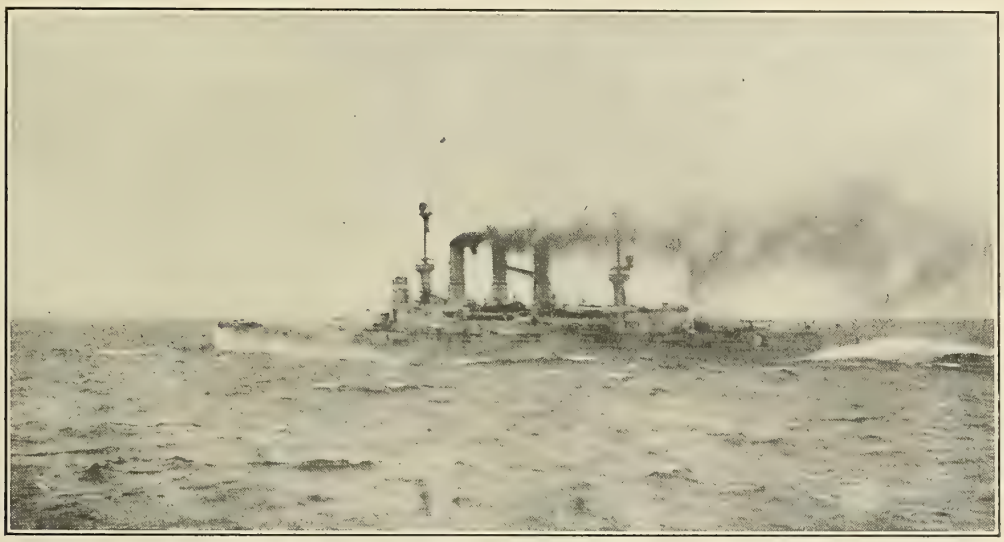
Some of the principal scantling members have been given as follows by *Schiffbau*:

Flat keel, 1¼ inches; garboard strake, 1 1/16 inches; bottom strakes, 15/16 inch; bilge strakes, 1 inch, 1 inch and 1 1/16 inches; side plates, 15/16 inch; sheer strake, 1 inch; center line vertical keel, 15/16 inch; double bottom horizontal center plate, 11/16 inch; double bottom side plates, 9/16 inch; upper deck stringer plate, 15/16 inch; inner stringer plate, ¾ inch; middle deck stringer plate, ¾ inch; other stringer plates, 9/16 inch; deck plating on the upper deck, 9/16 inch; on the middle deck, 7/16 inch; on the other decks, ⅜ inch. The depth of the double bottom is given as 5 feet 4 inches, and the frame spacing as 36 inches. The frames are channels measuring 10 by 4 by 4 by 21/32 inches. The deck beams on the upper deck are channels 8 by 4 by 4 by ½ inches. The deck beams on the middle, lower, and orlop decks are channels 10 by 3½ by 3½ by ½ inches. Hold beams measure 10 by 4 by 4 by ½ inches.

Obituary.

Harrison Loring, one of the pioneer iron steamship builders of the United States, died at South Boston, Mass., Dec. 26, at the age of 85. He opened a machine and boiler shop in South Boston in 1847, and in 1857 began the building of iron steamships. Among those which he constructed for the United States Navy were the old monitor *Canonicus* and the small cruiser *Marblehead*.

Commander Harry H. Hosley, U. S. N., died in the New York Yacht Club on Jan. 6. His successful pilotage of the floating drydock *Dewey* from Sparrows Point, Md., to Olongapo, Philippine Islands, was watched with intense interest all over the world.



BROADSIDE VIEW OF THE POMMERN RUNNING AT FULL SPEED.

A Mammoth New Atlantic Liner.

There is under construction in the Belfast yard of Harland & Wolff an immense passenger steamer for the Hamburg-American Line which has many points of interest entirely aside from its size. A principal feature is the fact that this ship is to be fitted with a combination of reciprocating and turbine machinery, there being provided three screws, of which the two outer ones are actuated each by a quadruple expansion steam engine, while the center shaft is turned by a low-pressure steam turbine, the steam for which is given by the exhaust from the piston engines. The total horsepower will be some-

THE TRANSPORTATION OF REFRIGERATED MEAT TO PANAMA.*

BY ROLAND ALLWORK.

This paper is intended to give a description of what has been done in the way of transportation of refrigerated meats to Panama, for the use of the thousands of men and their families who are located on the Isthmus, to build the greatest of all artificial waterways, known as "The Panama Canal." It is generally known that in tropical climates beef will not keep more than a day or so; it therefore has to be eaten the same day that it is killed. There is therefore a very urgent need for cold storage facilities on the Isthmus. Plans and specifications were made for a reinforced concrete building with 50,000 cubic feet of refrigerated storage.

The next step was to equip the steamers of the Panama Railroad Steamship Line with cold storage. We had at that time five steamers in service on this line: The *Advance* and *Finance,* of 2,600 tons; the *Allianca,* 3,000 tons, and the *Colon* and *Panama* (formerly the *Mexico* and *Havana,* of the Ward Line), 5,600 tons. The *Mexico* was the only steamer that was equipped with mechanical refrigeration.

On the latter steamship the cold storage for cargo was located on the orlop deck, aft of the engine room. The system of refrigeration was the ammonia compression system. The compressor, condenser, brine tank and brine pump were located in a small room marked "Machinery," leading out of the main engine room. The plant is what is rated as a 3-ton plant. It consisted of a duplex compressor 4 by 9 inches, operated by a single engine, 7-inch diameter cylinder, 7-inch stroke, an inclosed condenser and inclosed brink tank.

In commercial refrigerating or ice machines there are four principal refrigerants used—ammonia, carbonic gas, sulphurous acid and air. I will not go into the relative merits of these refrigerants, but ammonia was chosen because it is most generally used by packing houses, and we did not wish to deviate from the well-trodden path. Of the several ammonia systems in use, the ammonia compression system with cold brine circulation is the best suited for ship refrigeration, and this system was therefore installed on our boats.

This system consists of the following parts: Ammonia compressor; ammonia condenser; ammonia receiver; brine cooling tank; brine circulating pump; brine cooling coils in cold storage rooms. The process of refrigeration is as follows:

The liquid anhydrous ammonia is allowed to expand from the ammonia receiver into the coils of the brine cooling tank. In expanding from a liquid into a gaseous state in these coils, the ammonia cools the brine surrounding the coils to a low temperature. From the coils in the brine cooling tank the ammonia gas is drawn into the compressor, where it is compressed and forced through the ammonia condenser, in which the hot, dense gas from the compressor is cooled off to the temperature of the cooling water and returned again to the receiver in its liquid state, ready to be again expanded into the brine cooling coils, thus repeating its circulation over and over again. The cooling water in the condenser takes away from the ammonia the heat which it has acquired during compression, and also absorbs the heat transferred to the ammonia while producing refrigeration in the brine cooling coils.

The brine part of the plant operates as follows:

The body of brine contained in the brine tank is cooled by the ammonia coils in the tank. This cold brine is taken from the bottom of the brine tank, and by means of a pump is circulated through the cooling coils in the cold storage room, and then again discharged into the top of the brine tank. The temperature of the brine leaving the coils will be several degrees higher than the initial temperature of the brine, but in the brine cooling tank the brine is again lowered to its initial temperature. Salt or chloride of calcium can be used for the brine, but the latter is preferable on account of its lower freezing point, and its non-corrosive action on the pipes.

In place of the brine cooling tank and the submerged condenser used on the steamers *Colon* (*Mexico*) and *Panama* (*Havana*), we have installed on the steamers *Advance* and *Finance* a double-pipe brine cooler and double-pipe condenser, which possess some advantages over the former. In the brine cooler plants, the brine is pumped through the cooler, where it is cooled by the ammonia, and from there it passes through the cooling coils in the cold storage room, and is then discharged into a brine return tank. From the brine return tank the pump takes the brine and again passes it through the brine cooler and coils, repeating the above operations over and over again.

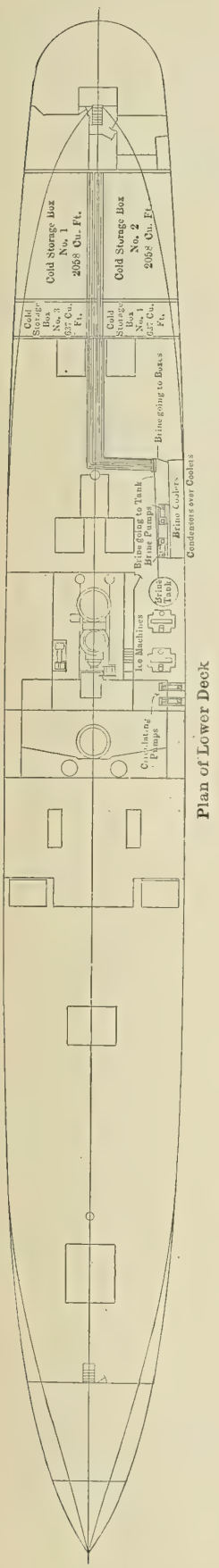
The brine coolers used on the *Advance* and *Finance* are of the double-pipe, or pipe-within-a-pipe type, each consisting of one coil of 3-inch and 2-inch ammonia pipe, 6 pipes high and 18 feet long. Each cooler contains in all 108 lineal feet of 2-inch pipe = 67 square feet of cooling surface. The refrigerating capacity of each cooler is 8 tons. The 2-inch pipe is placed within the 3-inch pipe, the ammonia expanding in the annular space between the two pipes, and the brine circulating through the inner 2-inch pipe. This type of brine cooler is very effective, takes up comparatively little room, is easily repaired and is always accessible for inspection.

Another type of brine cooler much used is the shell cooler, consisting of a strong wrought iron or cast iron shell, with a number of spiral coils placed inside the shell. The ends of the coils pass through the top and bottom heads of the shell, and are connected to headers. The ammonia is expanded into the lower part of the shell, and the compressor takes the ammonia gas from the top of the shell; the brine enters the spiral coils at the top and passes out at the bottom. This type of cooler has some points of advantage over the double-pipe type. The ammonia gas in the shell completely envelops the brine coils and remains a long time in contact with them, and as the shell area is very large compared with the small annular ammonia space in the double-pipe cooler, the gas meets with much less frictional resistance. The shell cooler also takes up less floor space than the double-pipe cooler, but it requires more head room, is less accessible for repairs and inspection, and the first cost is greater.

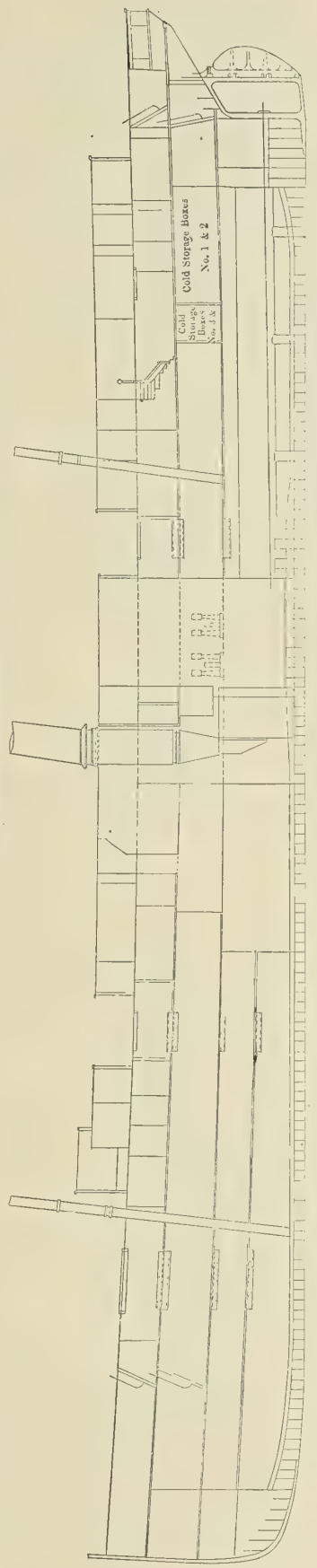
A brine system equipped with an outfit of the above-mentioned brine coolers, while practically having all the advantages of the direct expansion system, has none of the disadvantages of the latter system. It will produce refrigerating results almost as quickly as the direct expansion; it is more safe, as all the ammonia parts are confined in one place, and no ammonia is circulated in the cold storage rooms. It is more simple to operate and to control, and a more even temperature can be maintained in the rooms. In case of stoppage of the compressor, there is always a supply of cold brine on hand in the brine cooling tank, or brine return tank, to run the plant for some time. This is not possible with a direct expansion plant, and the refrigeration ceases immediately when the machine stops.

The brine return tanks on the *Advance* and *Finance* have a sufficient storage capacity to maintain a temperature in the rooms, with a very little loss, for about four or five hours, should the machine have to be stopped for any reason. The condensers on these ships are also of the double-pipe type, of precisely the same construction as the cooler before described. Each condenser consists of one coil of 2-inch and 1¼-inch pipe, six pipes high by 19 feet long. The total number of lineal feet of 1¼-inch pipe in the condenser is 114 feet = 50 square feet of cooling surface. Condensers, each 7½ tons refrigerating capacity.

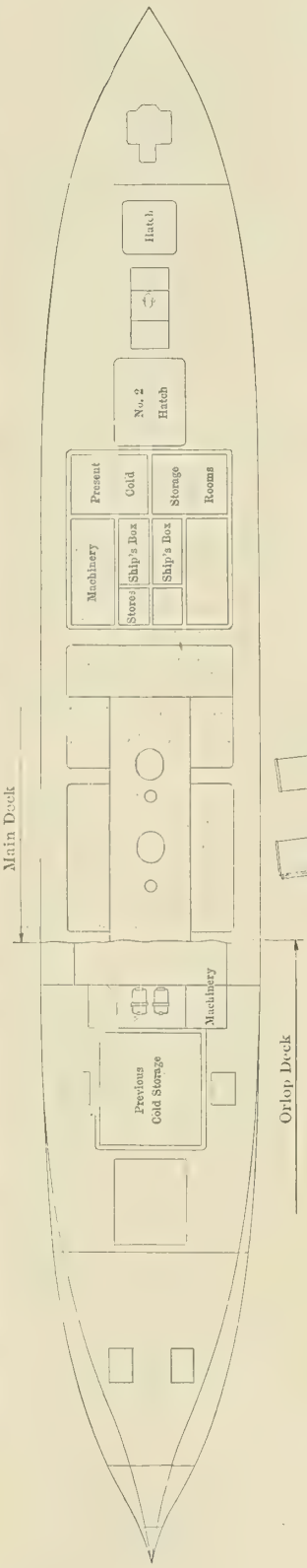
* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 22, 1907.

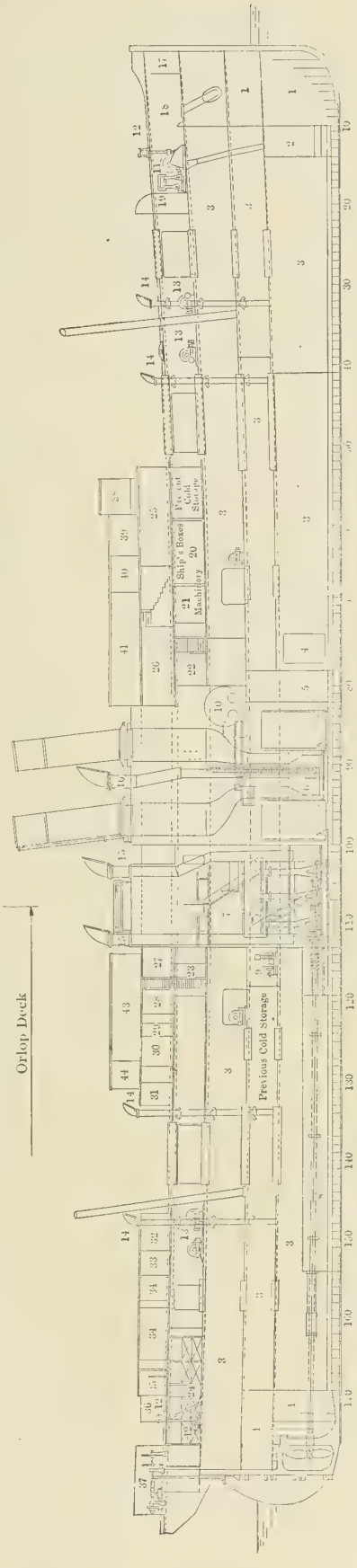

Cold Storage Box No. 1 2058 Cu. Ft.
Cold Storage Box No. 2 2058 Cu. Ft.
Cold Storage Box No. 3 537 Cu. Ft.
Cold Storage Box No. 4 1560 Cu. Ft.
Brine going to Boxes
Brine Coolers
Condensers over Coolers
Brine Cold Tank
Brine Pumps
Brine Tank
Ice Machines
Circulating Pumps

Plan of Lower Deck



DECK PLAN AND LONGITUDINAL SECTION OF THE STEAMERS ADVANCE AND FINANCE, SHOWING LOCATION AND LAYOUT OF THE NEW REFRIGERATING PLANT.





DECK PLANS AND INBOARD PROFILE OF THE STEAMERS COLON AND PANAMA, SHOWING LOCATION AND LAYOUT OF OLD AND NEW REFRIGERATING PLANTS.

1, Trimming Tank (Magazine). 2, Chain Locker. 3, Cargo Space. 4, Fresh Water Tanks. 5, Coal Bunker. 6, Boiler Room. 7, Engine Room. 8, Shaft Alley. 9, Dynamo Room. 10, Donkey Boiler. 11, Steam Windlass. 12, Steam Capstan. 13, Steam Winches. 14, 15, 16, Ventilators. 17, Stores. 18, Crew Space. 19, Hatch. 20, Ice House. 21, Stores. 22, First-Class Galley. 23, Baggage. 24, Steerage. 25, First-Class Dining Saloon. 26, Pantry. 27, Specie Room. 28, Stewardess. 29, Linen. 30, 31, First-Class Lavatory and Bath. 32, Second-Class Dining Saloon. 33, Pantry. 34, Second-Class Quarters. 35, Lavatory. 36, Steerage Companion. 37, Steering Engine. 38, Pilot House. 39, Captain. 40, Officers. 41, Social Hall. 43, Smoking Room. 44, State Room.

The ammonia gas passes through the annular space between the 2-inch and 1¼-inch pipe, and the circulating sea water is passed through the 1¼-inch inner pipe in the opposite direction to the ammonia, thus producing a counter-current effect, which cools the ammonia gas in the most effectual manner, keeps it in intimate contact with the cooling surface, and discharges the cooling water within a few degrees of the temperature of the gas. This type of condenser will therefore use less water, and requires considerably less cooling surface, than any other type of condenser.

The only objection to this type of condenser is that sea water in time fouls the pipes, and we find it somewhat troublesome to clean these pipes, but I understand that in later types of double-pipe condenser this objection has been overcome, and the water pipes can now be easily and quickly cleaned without disturbing any ammonia joint.

One of the drawings shows the construction of the double-pipe condenser. The brine cooler is constructed in the same manner, but uses larger pipes. I also show in one of the drawings attached with this paper a plan of an inclosed submerged condenser used on the *Mexico* and *Havana,* which explains itself. The condenser of the refrigerating plant of the *Mexico* was larger on account of its being a larger plant, but this shows the type used, and this also applies to the cooling tanks, which are constructed in the same way, but which are larger. The condenser consists of a cylindrical shell of steel plate, 4 feet 2 inches diameter and 4 feet 8 inches high, with two coils of 1¼-inch diameter extra heavy pipe, the total lineal feet of coil being 450. The ammonia is pumped through the coils, and the water circulates in the tank on the outside of the coils.

The brine cooling tank was constructed in the same way, except that it was larger and had three coils instead of two—dimensions being 5 feet diameter, 5 feet 8 inches high, 900 lineal feet of 1¼-inch pipe coils. In this tank, the ammonia expands through the coils, cooling the brine in the tank surrounding the coils. There was one cold storage room, with the brine coils on the walls and ceiling.

The first plant was used by the Ward Line to carry meat to Cuba, and had from the information received given every satisfaction. For the purpose of the Panama service it had also some defects, the principal ones of which were the location of the cold storage room, which was, as before stated, away down in the hold, and the fact that the room was not sub-divided, thereby requiring the carrying of only one temperature for all commodities.

The *Havana* was at this time undergoing repairs in New York, and instructions were given to equip her with mechanical refrigeration of the same capacity as the *Mexico.* The most convenient location for the cold storage on this ship (which is a sister ship to the *Mexico*), was found to be on the main deck aft of No. 2 hatch; there was just room enough to erect two cold storage rooms, with an aggregate capacity of 3,000 cubic feet (the same capacity as the one room in the *Mexico*), and orders were given to proceed with the work on this basis. The advantages of this location were found to be twofold.

In the first place, it enabled the delivery of meats and vegetables immediately upon the ship's arrival in port, without waiting for the cargo out of the hold to be discharged first, and in the second place it easily enabled us to pipe the ship meat boxes, which were located directly aft of these rooms, and which were formerly cooled with ice. The ship's boxes were originally designed only large enough for the run from New York to Havana, and were not of sufficient capacity for a run from New York to Colon, approximately twice the distance. By using brine pipes instead of ice it increased the capacity of the ship's boxes. The brine pipes used were 2-inch galvanized pipes, and the ratio of cubic feet of refrigerated space to lineal feet of 2-inch pipe was 2.6 to 1 or 4.4 cubic feet of refrigerated space to one square foot of cooling surface.

The machinery was an exact duplicate of that in the *Mexico,* but instead of being located in the engine room, as in the *Mexico,* it was located on the port side, aft of the refrigerated rooms. The advantage of this location was found to be so apparent that new cold storage rooms were afterwards built on the *Mexico,* similar to those on the *Havana.* A 5-ton plant was, however, put on the *Mexico* instead of a 3-ton plant, as it was found that the 3-ton plant was operated nearly to its limit. The machinery was of the same type.

The insulation of the cold storage rooms consisted of matched spruce boarding, with the inner space packed with spruce shavings. Spruce was used, as it gives no odor; and the shavings do not "pack" or shake down like sawdust, as their elasticity keeps them in place. The shavings were short, and were made by an ordinary rotary planer, and I consider it, when cost is taken into consideration, the most efficient insulation that can be adopted. There is one disadvantage, however. It requires a thicker wall (over twice the thickness) than cork insulation of the same efficiency, and great care must be taken to prevent moisture getting into the insulation, as this will quickly destroy its insulating qualities. It is, however, more economical in the first cost than cork blocks.

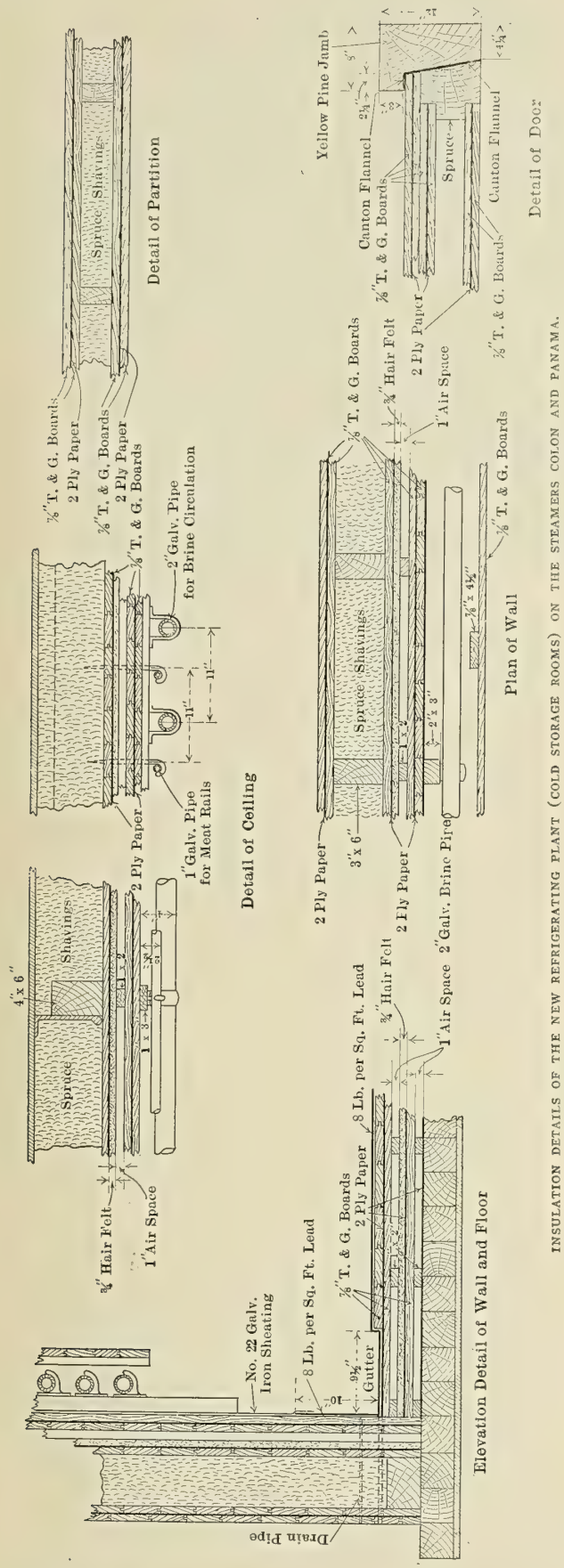
The cargo refrigerating rooms consisted of two rooms, each of the same dimensions and similarly piped with 2-inch galvanized iron brine coils. The brine pipes were in two groups in each box, that is, with a separate supply and return for each; one group was on the ceiling and the other on the walls. The rooms were piped the same so that, should occasion require it, either or both boxes could be used for the meat. The meat rails are 11 inches center to center, and are of 1-inch galvanized pipe. They are supported by long screwed hooks, screwed into 6 by 4-inch yellow pine timbers, which are bolted to the deck beams. The meat is carried on galvanized hooks, hung on the meat rails. The brine pipes are supported by galvanized iron clips on the ceiling, and by pipe brackets on the walls.

The floor is covered with 8 pounds per square foot of sheet lead, the planking forming the floor being doubled in the center in order to form a depression or gutterway 10 inches wide all around the edge, the gutter draining out through a pipe at the side of the house, which drain was plugged outside when the water had been drained off.

In the fruit and vegetable room it was found that some of the fruit and vegetables during one voyage showed signs of getting bad. This was due to moisture, and was remedied by putting two 12-inch electric fans in galvanized chutes or casings, so as to deliver a current of air around the brine coils, and between the walls and apron, the purpose being to condense the moisture in the air over the coils, and carry it away in the gutter. After this means was adopted there was no trouble with bad fruit or vegetables. But I have come to the conclusion that if the fruit and vegetables are received in a not over-ripe condition, and if the door of the refrigerated room is not opened too often on the voyage, there would be no need of a fan, as they have been so carried without injury on the *Advance* and *Finance.*

The need for good wholesome meat on the Isthmus was so urgent that it was necessary to carry it on the next incoming ship. The necessary machinery and material was purchased, and in five days after the ship's arrival one of the rooms was built and piped, and the meat stowed. Although so short a time was taken, the only part of the work that was omitted was the galvanized iron lining, which was put in upon the ship's return to port. The brine pipes in this room, of course, had to come down to do this.

Instead of 3,000 cubic feet capacity (as on the *Mexico* and *Havana*) it was decided to put in much larger capacity on the *Advance* and *Finance.* The capacity on these ships was made

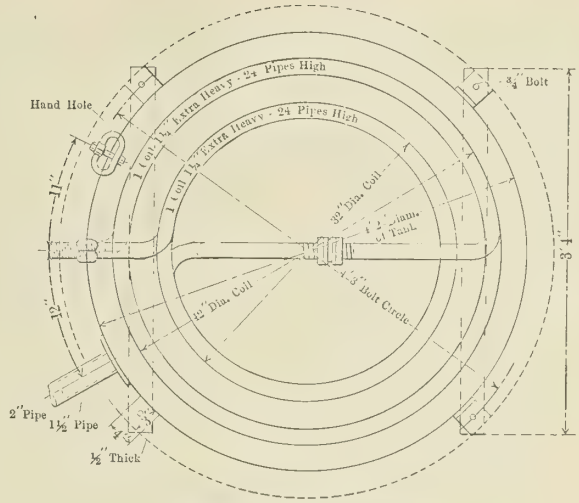


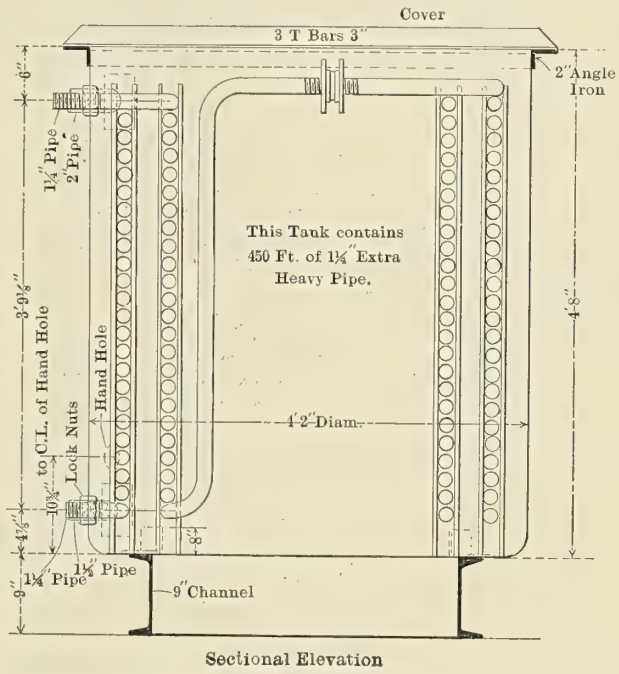
INSULATION DETAILS OF THE NEW REFRIGERATING PLANT (COLD STORAGE ROOMS) ON THE STEAMERS COLON AND PANAMA.

5,400 cubic feet. The meat chambers (of which there are two) were aft, and the fruit and vegetable chambers forward, forming vestibules to the meat chambers.

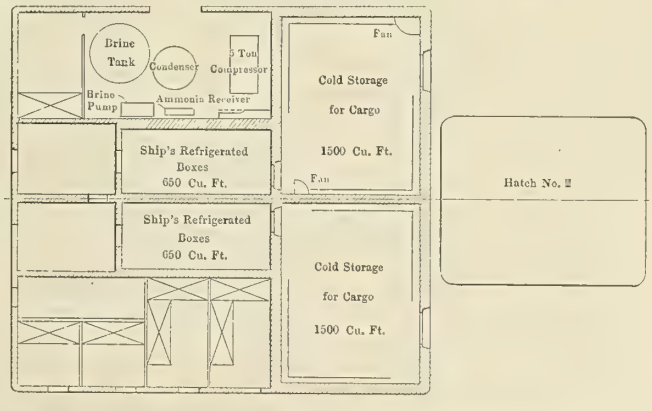
The brine pipes were in three groups in the meat boxes, and two groups in the vegetable boxes. They consisted of 2-inch galvanized iron pipes with galvanized return bends.

On account of the outside walls coming against the ship's side it was considered advisable to use cork insulation, and





REMINGTON MACHINE COMPANY CONDENSER TANK FOR STEAMER COLON.

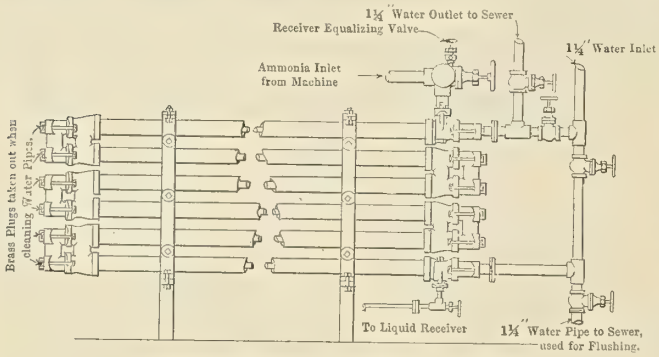


PLAN OF THE COLD STORAGE PLANT ON THE COLON AND PANAMA.

in order to simplify construction, cork was then decided on for walls, ceiling and floor. The ship's side was wire-brushed clean, and two coats of white lead and zinc were put on and cork dust thrown on it while it was wet. A layer of granulated cork was then put in the spaces between the frames. In these chambers the floor was covered with lead similar to that in the *Mexico* and *Havana,* with a gutter all around, but this deck being below the waterline, the drains were carried into the bilges.

In considering the most important points in the construction of the rooms, I would say that it is important to get the joiner work carefully done, also the cork sheets (which are 2 inches thick), cut square and properly butted; in fact everything to prevent the circulation of air or the admission of moisture. The galvanized iron lining should be 24 gage, lock seamed; in these cases it was also soldered, but I do not think that this added to its efficiency.

The pipe hangers should be wrought or malleable iron galvanized, but I do not know that it is necessary to use galvanized pipe for brine coils, as the life of the pipe is limited to the life of the threads, and the threads in galvanized pipe do not last longer than the threads in black pipe. I would, however, recommend that, if black pipe is used, it be cleaned and given a thin coat of graphite to protect it. The meat rails should be galvanized whether pipe or bars are used.


1¼" Water Outlet to Sewer
Receiver Equalizing Valve
1¼" Water Inlet
Ammonia Inlet from Machine
Brass Plugs taken out when cleaning Water Pipes.
To Liquid Receiver
1¼" Water Pipe to Sewer, used for Flushing.

DOUBLE-PIPE BUFFALO AMMONIA CONDENSER.

The rooms in the *Mexico* and *Havana* were not at first lined with galvanized iron, but the sheathing was shellacked. The meat chambers, however, have since been lined on the walls, as it is found easier to keep clean. In the *Mexico* and *Havana* the cold storage rooms, being on the main deck with plenty of light and air, are not hard to keep clean and in good order, even though the walls are of spruce sheathing. In the *Advance* and *Finance,* the rooms being below decks, it was considered advisable to line them as before stated with galvanized iron, so that a hose can be played on the walls and ceiling when the meat has been discharged, and the grating taken up and scrubbed.

The machinery on the *Advance* and *Finance,* which are identical, consists of two 7½-ton refrigerating machines, each having a 6-inch diameter by 12-inch stroke double-acting ammonia compressor, and a 9 by 12-inch steam engine; two double-pipe ammonia condensers, each of 7½ tons refrigerating capacity; two double-pipe brine coolers, each of 8 tons capacity; one brine return tank. Only one compressor, one condenser and one brine cooler is used, the other being held in reserve in case of accident.

There are two brine pumps and two circulating pumps for the condensers; only one of each is used, the other being held in reserve in case of accident. The size of each brine pump is 6 and 4 by 6 inches; of each circulating pump 6 and 5¾ by 6 inches.

The ratio of cubic feet capacity to lineal feet of 2-inch pipe in the cold storage room was 1.58 to one in the meat chambers; and in the fruit and vegetable chambers about the same. It was considered advisable to cover all the walls and ceiling with brine coils, and not to be governed too much by ratios, so as to get an even distribution of cold and to regulate the temperature in the chambers by the amount of flow of brine through the coils.

We have been fortunate enough never to have had a breakdown, and the provisions have arrived at the Isthmus in good condition. There are two refrigerating engineers carried on each steamer, and they stand six-hour watches. These ships, however, carry barely enough for the immediate needs of the Isthmus; it will, therefore, be necessary to carry periodically larger quantities, in regular refrigerated ships, so as to stock the cold storage building at Colon, our steamers being capable of keeping up the stock probably for three or four months.

The Austrian Steamer Marina.

The steamship *Marina,* built by Robert Stephenson & Company, Limited, Hebburn-on-Tyne, to the order of the Navigazione Libera Triestina Società in azione, of Trieste, has undergone successful loaded trials and departed for Trieste, her port of registry. She has been built to take the highest class under Lloyds registry and the Austrian Veritas, and is of the single decked type, with no hold beams—her holds thus being clear of obstruction to stowage. She has been fitted with a steel center line bulkhead in lieu of hold pillars, while portable wooden grain boards are fitted in her hatchways, so that she may be available for taking bulk grain cargoes.

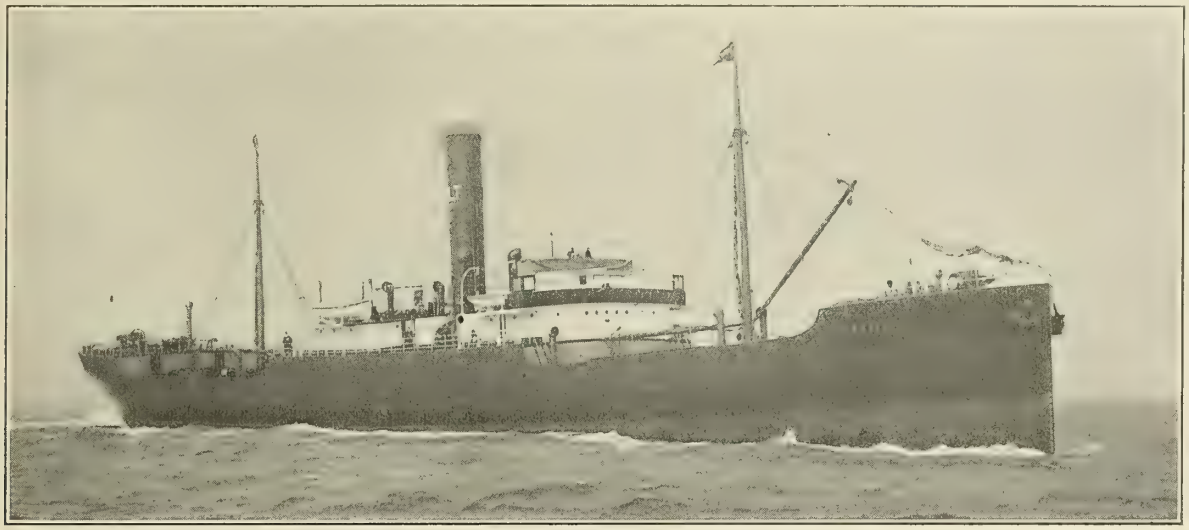
A cellular double bottom all fore and aft with dry well under boilers, and a large after peak tank extending to the upper deck, are fitted for water ballast, holding in all about 840 tons of salt water. Large hatchways are fitted over the four main cargo holds, with strong coamings of sufficient depth to hold 2 percent of the capacity of the compartment they feed, thus complying with the bulk grain carrying regulations, and a complete outfit of powerful steam winches and cargo derricks, with patent blocks and flexible steel wire runners, has been installed for working them. The cargo capacity is very large, being about 58 cubic feet per ton of deadweight. The vessel's dimensions are 317 feet 6 inches in length, 46 feet 6 inches molded beam, and 23 feet 3½ inches molded depth, and she has been designed to carry a large deadweight (4,700 tons) on a light draft.

A large and commodious steel deck house has been fitted on the forward end of the bridge deck, in which are placed the dining saloon, captain's cabin, two spare cabins, bathroom and toilet, also the steward's pantry and storeroom and steward's berth. The ship's officers and engineers are berthed in steel deckhouses built as part of the engine casing, above bridge deck, with doors in a passage entered from the after end, so as to be entirely sheltered in bad weather. The seamen and firemen are berthed under the topgallant forecastle, a separate house being provided for each class.

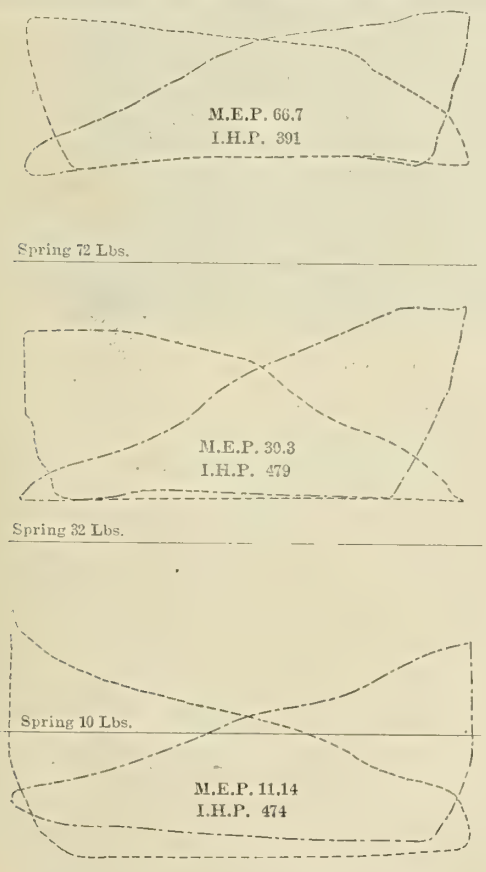
The machinery has been built by Richardsons, Westgarth & Company, Limited, at their Scotia Engine Works, Sunderland. The cylinders are 23, 38 and 62 inches in diameter by 42-inch stroke. The high-pressure cylinder and the high-pressure piston valve have separate hard cast iron liners. The go-ahead and go-astern guides are carried on independent front and back cast iron columns. The crank shaft is in three interchangeable parts, and is made of ingot steel throughout, while the bedplate is sufficiently deep to be bolted direct on to the tank top, without intermediate built-up seating. The all-round reversing gear is driven by an independent steam engine, the latter also, by means of patent link chain, operating on the turning gear. Every bearing throughout the engine is adjustable and easily manipulated while the engine is running, and all the white brass used in the engine and thrust block is of the finest quality.

The surface condenser is provided with large steam space and cooling surface; all the tubes are packed with cotton packing and close ended screwed brass ferrules. The pumps are worked from the intermediate engine crosshead by means of steel plate levers, and, although long links connect the levers to the pump crosshead, an independent adjustable guide is also fitted. The air pump is single acting, with brass valves; the circulating pump being double acting and with india rubber valves, while both feed and bilge pump rams, valves and chests of gunmetal throughout, and the bilge pump doors are easily removable without the aid of spanners. Duplex feed pumps with gunmetal water ends are fitted for harbor work, while a large ballast pump, connected to pipes and valves of fully twice the usual size, enables water ballast to be discharged quickly.

Steam is supplied by two Scotch boilers 15 feet in diameter by 10 feet 6 inches long, containing 4,200 square feet of heating surface, and fitted each with three patent corrugated and withdrawable furnaces. They operate at 160 pounds pressure. All the machinery has been built to pass Lloyd's special survey. The boilers and steampipes are covered with S. T. Taylor & Sons' "Tynos" non-conducting sheathing.



THE STEAMSHIP MARINA MAKING 10¼ KNOTS ON TRIAL TRIP.



INDICATOR CARDS FROM ENGINE OF MARINA.

During the trial trip, April 19, the engines worked with perfect smoothness, and gave great satisfaction to both owners and builders. The tracing of the cylinder diagrams taken during the trials shows a total horsepower of 1,344, on 66½ revolutions per minute. The speed was 10¼ knots with a half cargo aboard.

Clyde-Built Steamers for Canadian Lakes.

The Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow, launched, last summer, within a few days of each other, two interesting vessels for the Canadian Pacific Railway Company's service on the Great Lakes. The vessels are named *Assiniboia* and *Keewatin*, and as they are sister ships, a description of one applies to the other also. The principal dimensions are: Length, 348 feet; breadth, 43 feet 6 inches; depth 26 feet 9 inches to awning deck; gross tonnage, 4,300. Each is divided into seven watertight compartments. There are four decks; main, awning, promenade, and hurricane deck.

The fore part of the ship is divided into three compartments for the carrying of grain or other cargo, the former to be put on board through trunked hatches from the hurricane deck. The working of the cargo is accomplished by means of an overhead revolving shaft 140 feet in length, driven by a double-cylinder steam-hoisting engine with two revolving drums, with clutches to each of the five hatches to insure rapid manipulation.

Powerful appliances for working the vessel include a large windlass and capstan forward, and two warping capstans aft.

The propelling machinery consists of a single quadruple expansion engine having four cylinders working on four cranks, balanced on the Yarrow, Schlick & Tweedy system. The high-pressure and first intermediate cylinders are fitted with piston valves; and flat valves of the double-ported type are fitted to the second intermediate and low-pressure cylinders; all worked by the usual double-eccentric valve gear, controlled by steam gear of the all-'round reversing description. The crankshaft is of the built-up type, and (as also the thrust and propeller shafting) is of forged mild ingot steel. The propeller has four blades of cast steel secured to a boss of the same material.

Water is circulated through the condenser by an independent centrifugal pump, having also a suction to the engine-room bilge to enable a large quantity of water to be pumped out of the ship in case of need. Independent air, bilge and sanitary pumps are fitted for boiler-feed, ash ejectors, ballast and general service purposes, and in the engine room there are a feed heater and a feed filter.

The four boilers are of the cylindrical return tube type, and are arranged to work with natural draft. They are constructed entirely of steel, for a working pressure of 220 pounds per square inch. An ash ejector is fitted in each stoke-hold.

The entrance to the passenger accommodation is on the main deck, amidships, where is a large spacious hall with two staircases. The entrance hall is panelled in teak, with ornamental balustrade to the stairs, and the floor is laid with interlocking rubber tiles. Forward of the main entrance is the at the fore end of this deckhouse, and is tastefully finished in white enamel and gold. The main feature of this room is the formation of the sofa seats, which are arranged in bays, forming "cozy corners," with seats upholstered in frieze velvet. Writing tables and easy chairs are also fitted.

Amidships, immediately abaft the hall, is the dining saloon, capable of seating 116 persons. The framing is finished in American walnut, with Italian walnut panels. Large rectangular beveled glass horizontal sliding windows, together with a large dome skylight overhead, give ample light and ventilation. The floor is laid with polished oak parquetry with walnut border. Handsome sideboards are fitted to match the framing.

The smoking room is at the after end of the deckhouse, and is designed in light fumed oak with carved panels. Chairs and tables are in oak to match, and the sofa seats are upholstered

THE ASSINIBOIE JUST AFTER BEING CUT IN TWO IN LEVIS DRY-DOCK.

package freight deck, access to which is obtained by large double doors through the ship's side.

The awning deck is arranged for the accommodation of 195 first-class passengers in two and three-berth rooms, fitted with patent folding berths, sofa berth, wash basin with running water, etc. Aft of the main staircase are five cabins-de-luxe, panelled in mahogany and oak, with large brass bedsteads, folding lavatory and sofas, and private bathrooms. The chief feature of the awning deck is a large central hall, about 140 feet in length, tastefully furnished with settees to match the surrounding framing.

On the promenade deck is another spacious hall in a large deckhouse, with a well in the center which gives light to the central hall below. On either side there is accommodation for seventy first-class passengers, in three-berth staterooms, furnished similarly to the staterooms on the awning deck. Large windows are fitted with venetian blinds and curtains, which can be left open in any weather. The drawing room is in Morocco leather. The floor is laid with terra-cotta and white interlocking rubber tiles. Between the smoking room and the dining saloon are the pantry, galley, and cold chambers, with all the latest facilities for catering to a large complement of passengers. The public rooms and the accommodation throughout the vessel are fitted with ornamental vertical radiators, each of which can be independently regulated.

The hurricane deck is 275 feet in length and forms a spacious promenade, to which access is gained by stairways at the fore and after ends. At the forward end of this deck there are the captain's and officers' rooms, and wheelhouse with flying bridge over. Eight steel lifeboats are fitted under davits, in compliance with the steamboat inspection act.

The vessels represent an interesting piece of work, on account of the fact that they have been specially constructed so that on reaching the other side of the Atlantic they might be divided amidships into two parts, each part being towed separately through the canals which lead to the Great Lakes,

where the sections could be again rejoined. As the lock of the Canadian canals are not of sufficient size to contain vessels of the length of these two, it has been necessary to resort to this expedient. Watertight bulkheads have been constructed on either side of the dividing line. The sections had to be towed through a couple of canals (Lachine and Welland), and a lake (Ontario), of about 200 miles in length, before reaching the field of operation.

MECHANICAL DRAFT IN MARINE PRACTICE

BY WALTER B. SNOW.

The first application of the fan blower as a substitute for or as an auxiliary to the chimney appears to have been made early in the last century. It is said that in 1826 John Ericsson fitted the British steamer *Victory* for forced draft by means of a fan, and it is certain that in 1830 the *Corsair* was so equipped by him. At about the same time, in 1827, Edwin A. Stevens, of Bordentown, N. J., arranged a fan for forcing air into the ashpits of boilers on the steamer *North American.* But engine speeds and steam pressures were then low; the demand for accelerated combustion was not urgent, and experience had not been gained in the proper application of fans for forced draft. As a consequence, this economic improvement, which was to mean so much in later days, was adopted to but a limited extent.

The fact that these first applications were made on steam vessels indicates the natural adaptability of the fan for the purpose. It is, therefore, not surprising to find that the arrangement was again taken up, this time by the United States, during and subsequent to the civil war. Extensive tests were conducted by Chief Engineer Isherwood, but there remained still another stage in its progress toward general application, both on sea and land.

The advent of the torpedo boat marked the further introduction of forced draft for marine boilers. In these small, compact vessels tall stacks were out of the question, but strong draft and the utmost steaming capacity per ton of weight were an absolute necessity. From success with these smaller boats it was but a natural step to those of larger size. In 1877 the French government equipped the scout boat *La Bourdonnais* for forced draft, and in 1882 a definite move was made in the British navy by providing fans for the production of draft on the *Satellite* and *Conqueror.*

The general conditions of naval practice which existed at that time, and the immediate results secured by increasing the steam pressure, improving the type of engine and introducing mechanical draft, are set forth in Table I.

Table I.—Results of Trial Performance of Similar Ships in British Navy.

Draft	SHIP	Date	Steam Pressure, Pounds per Square Inch.	I H.P.	Weight of Boilers. Tons	Area of Fire Grate Square Feet.	I. H. P. per Square Foot of Grate.	I. H. P. per Ton of Boiler.
Natural Draft, Open Fire Rooms.	*Inflexible*	1878	60	8,483	756	829	10.21	11.22
	Colossus	1883	64	7,492	594	645	11.62	12.61
	Phaeton	1884	90	5,588	462	546	10.23	12.1
Forced Draft, Closed Fire Rooms.	*Howe*	1885	90	11,725	632	756	15.54	18.5
	Rodney	1885	90	9,544	474	567	16.83	20.1
	Mersey	1885	110	6,628	306	399	16 61	21.7
	Scout	1885	120	3,370	174	207	16.28	19.3

The weight of boiler includes water, funnel, uptakes, fittings, spare gear, etc. Steam blast was used in the case of the *Colossus.*

Shortly after this, the United States navy again took up this important factor in the design of the modern naval vessel, and introduced forced draft upon all of the vessels of the "new navy." Among the first so equipped was the dispatch boat *Dolphin.* The general design of her three forced draft fans, with cast iron shells, would now look exceedingly cumbersome in view of the present light steel plate construction. From the navy it was but another step to the merchant marine.

On land, the process of development during the past few years has been remarkable. From the under-grate forced-draft system there has been a gradual change to the over-grate induced system, and a combination of the two, until the matter of mechanical draft engages the attention of every progressive engineer in the design of a steam plant. In stationary practice the fan is applied as a substitute for the chimney. In a more restricted sense this is true in the merchant marine, but in the warship, except in the torpedo-boat type, it is usually regarded as an accessory, to be employed only when the ordinary cruising speed is to be exceeded.

Although its simplicity has much to recommend it, the steam jet becomes a competitor of the fan only where economy of fuel receives secondary consideration. Its low efficiency was well shown by a series of tests made some years since at the New York navy yard, whereby it was demonstrated that from 8 to over 20 percent of the steam produced by a boiler was consumed by the jet. In stationary practice the fan seldom exceeds a consumption of 1½ to 2 percent of the steam generated by the boilers to which it is applied; in large plants it is usually far below these figures. On the contract trial of a modern battleship the indicated horsepower of the fire-room blowers may range up to a possible 1¾ percent of the aggregate indicated horsepower of the main engines and auxiliaries.

The ordinary fan wheel is too well known to require illustration. Its action may be well illustrated by whirling a tube about an axis established at right angles to its own and midway of its length. From the open ends the air is thrown outward by centrifugal force, while a partial vacuum is created at the axis of revolution. If an opening be provided at this axis, air will flow in, and thus a constant current through the tube will be maintained.

In effect, a centrifugal fan wheel is a series of such tubes radiating from an open center, each being represented by the space inclosed between two adjacent blades and the side plates. Through each of these channels the air is thrown into the surrounding atmosphere, or into the case which incloses the wheel. For general purposes it is customary to inclose the fan within a spiral case, which provides a constantly increasing area for the passage of air as it approaches the outlet, from which it may be discharged through a pipe to the desired point of final delivery. Curved blades are employed to decrease the noise, rather than to improve the efficiency.

The maximum velocity at which air may be delivered by a cased centrifugal fan through an outlet of proper area is substantially equal to that of the circumference of the wheel, while the pressure created corresponds thereto, being proportional to the square of the velocity. This area, commonly known as the capacity area, depends upon the proportions of the wheel, but in general practice approximately equals one-third of the diameter in inches, multiplied by the width at the rim in inches, as expressed by the formula $\frac{1}{3}\ DW$. It is usually much less than that of the regular outlet in the casing. If the capacity area is reduced, the volume will be proportionately decreased, the power will decrease, but not in the same ratio, while the pressure will remain substantially constant.

The size of the outlet in the casing is not a function of the capacity area, but is determined largely by the attendant

conditions. But both the volume and the power required will evidently increase with the size of the outlet, being greater with the normal outlet than with that representing the capacity area. This increase, however, will not be proportional to the area, for the pressure and consequently the velocity will be lower with the larger area. The greatest

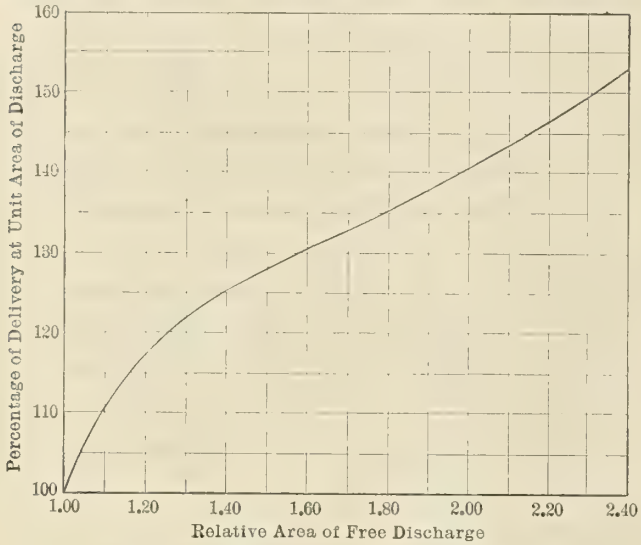


FIG. 1.—RELATIVE DELIVERY OF A CENTRIFUGAL FAN.

delivery of air and the largest consumption of power will occur when the casing is entirely removed and the fan left free to discharge around its entire periphery. The influence of the area of outlet upon the volume discharged is well illustrated by the curve in Fig. 1, presenting the results of tests of a standard fan.

The standard type of fan of medium size usually installed on shipboard consists of a shell of No. 10 or 11 steel plate, with 1½-inch corner angles rolled to the shape of the scroll.

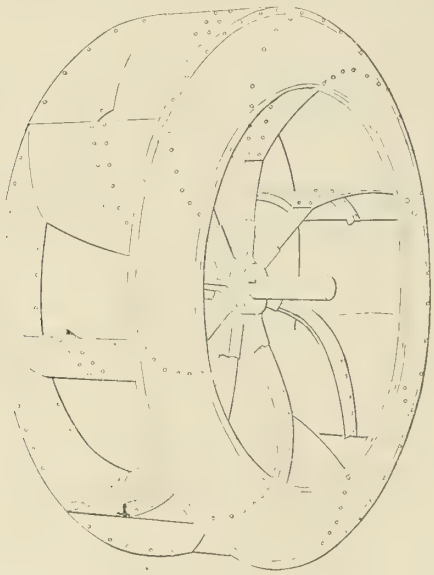


FIG. 2.—TYPICAL FAN WHEEL WITH CURVED BLADES.

The wheel itself is usually built up of No. 12 or 14 gage, and carried upon a hub with 1¾-inch or 2-inch T-iron arms cast in. The outlet frame is of cast iron or angle iron, according to the shape and type of fan. The type is illustrated in Fig. 2.

The forced draft fan is almost universally steam driven by a direct connected motor, either in the form of a reciprocating engine, as has been customary in the past, or by a turbine, as in some installations more recently made. A typical fan with double-cylindered engine is shown in Fig. 3.

But as such fans have in the naval service usually been under the direct control of the fire-room force, it is evident that ability to withstand the most ignorant treatment is essential, rather than high efficiency. In the case of the reciprocating engine, the short-stroke double cylinder type was almost universally adopted. The cranks are set at 180 degrees, to give approximate balance of the reciprocating parts, which are entirely inclosed. In the prevailing type of past years, clearance was sacrificed to simplicity, and the steam for the second cylinder passed through the first instead of through independent ports.

In the design of a wheel to meet given requirements it is necessary to make its peripheral speed such as to create the desired pressure, and then so proportion its width as to provide for the required air volume. Evidently, the velocity and corresponding pressure may be obtained either with a small wheel running at high speed, or a large wheel running at low speed. But if the diameter of the wheel be taken too small, it may be impossible to adopt a width within reasonable limits which will permit of the passage of the necessary amount of air under the desired pressure. Under this condition it will be necessary to run the fan at higher speed in order to obtain the required volume. But this results in raising the pressure above that desired, and in unnecessarily increasing the power required. On the other hand, if the wheel be made of excessive diameter it will become almost impracticable, particularly on shipboard, on account of its narrowness. Between these two extremes a diameter must be intelligently adopted that will give the best proportions. In practice the width of a volume fan seldom exceeds one-half its diameter. In a fan for higher pressures than those which obtain in forced-draft practice, the proportion may run as low as one to twenty.

In American naval practice the rotative speed with reciprocating engines is not ordinarily allowed to exceed 500 revolutions per minute, while the diameter of the wheel ranges from 4 to 6 feet, except in the smaller vessels. As a rule, fans for closed fire-room service are operated at such peripheral speed as to maintain a pressure of about 4 inches of water over their capacity area. This pressure corresponds to a velocity of 7,825 feet per minute, which, with a wheel of 5½ feet diameter, would demand about 450 revolutions per minute. If called upon to deliver 30,000 cubic feet per minute through its capacity area, such a fan would require to be 2 feet in width at the rim. The relations existing between the volume discharged, the pressure created and the power required at a given speed are forcibly illustrated by the curves in Fig. 4.

Commercially, fans are classified as blowers and exhausters. The former type has an inlet upon either side, and cannot be readily applied for exhausting through connecting pipes.

The exhauster, which has an inlet upon one side only, is, however, so designed as to permit of free connection thereto. The fan is overhung upon the shaft, while the pulley or driving motor and both bearings are placed upon the closed side of the fan. Under this technical designation, the so-called forced draft "blower" is usually an exhauster, designed to draw its air from the atmosphere or from other parts of the ship through a single inlet.

A further rough classification may be made into volume and pressure fans. The former class particularly includes all fans designed for purposes of ventilation, mechanical draft and the like, in which quantity of air is the first desideratum.

Athough about 12 pounds of air is chemically required for the combustion of an average pound of coal, this amount

serves only when every individual atom of oxygen comes in contact and unites with corresponding atoms of hydrogen or carbon. The arrangement of the fuel upon the bed, and other circumstances, render this result impossible under working conditions. It therefore becomes necessary to supply the air in such excess as to make good any local deficiencies. Although, in actual practice, the air supply ranges

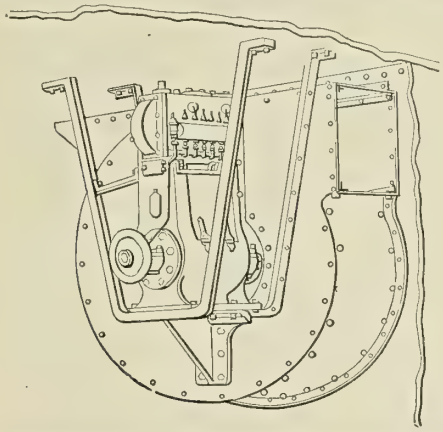


FIG. 3.—TYPICAL FAN WITH DOUBLE-CYLINDER ENGINE.

all the way from 50 to over 300 percent in excess of that theoretically required, it may be generally accepted that under good conditions of natural draft the volume is seldom less than twice that chemically required, though with mechanical draft it is possible to materially reduce this amount. Twenty-four pounds of air is equivalent to about 300 cubic feet at 60 degrees. Analysis of the gases escaping from the watertube boilers of the United States cruiser *Cincinnati*

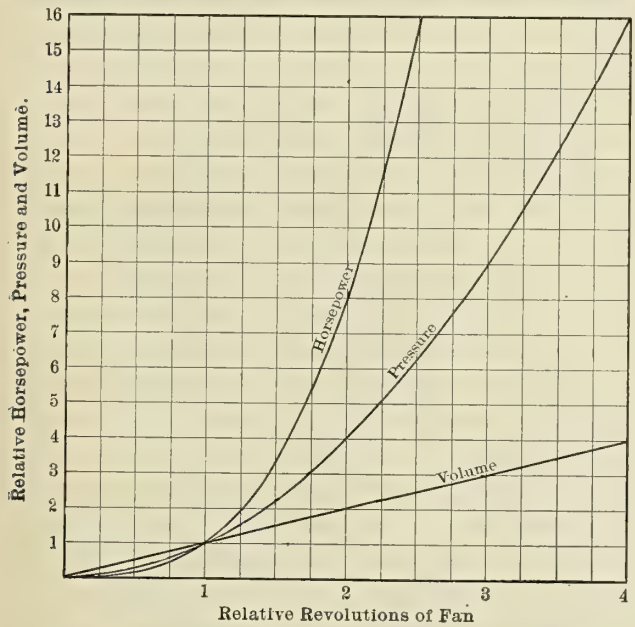


FIG. 4.—THEORETICAL RELATIONS INVOLVED IN OPERATION.

showed, for instance, an average of 19.6 pounds of dry gas per pound of carbon.

In boiler practice the force of the draft must be expended in two ways:

First, a portion is necessary to overcome the resistances of the grate and the fuel upon it, of the combustion chamber, flues or tubes and uptake, and of the means of connection to the source of draft, be it fan or stack. The sum of these resistances is a measure of the *pressure head.*

Second, the draft must, in addition, be sufficient to impart to the air the velocity necessary to furnish the amount requisite for the direct purpose of combustion. This is a measure of the *velocity head.*

With a constant total head, any change in the resistances immediately alters the relation between the pressure and the velocity heads. Thus, for instance, a thicker fire or finer coal increases the resistances and reduces that portion of the draft available for the production of velocity. As a result, the air supply becomes inadequate and greater total intensity of draft is necessary to maintain the original combustion rate.

A careful study of boiler resistance is necessary to a thorough consideration of the practical conditions of draft production. Prof. Gale found, in the case of a stationary boiler furnace of ordinary construction, the various pressures, expressed in pounds per square foot, in Table II.

TABLE II.—PRESSURE CONDITIONS IN STATIONARY BOILER FURNACE.

Required to produce entrance velocity (3.6 feet per second)	0.013
Required to overcome resistance of fire grate	0.91
Required to overcome resistances of combustion chamber and boiler tubes	1.23
Required to overcome resistance in horizontal flue	0.06
Required to produce discharge velocity (11.2 feet per second)	0.085
Total effective draft pressure	2.298
Back pressure due to friction in stack	0.19
Total static pressure produced by chimney	2.488

The total static pressure, which is given in pounds per square foot, is equivalent to 0.28 ounce per square inch, or 0.48 inch of water. From these results it is evident that only about 4 percent of the total draft pressure was actually expended for the production of velocity and the movement of air. Designs for draft-producing apparatus are not, therefore, to be based solely upon the volumetric requirements. If this were the case, a low stack or a large slow-running fan would meet the conditions. In reality, the design must first contemplate the creation of sufficient intensity of draft and then provide capacity for the necessary amount of air.

In the case of a chimney, the maximum draft, being dependent upon its height, is constant for the same temperature, and regulation of the combustion can be secured only by throttling the air supply. With a fan, however, the intensity of the draft may be instantly changed from zero to the maximum, with a proportional increase in the air volume. It must already be evident that only under the latter condition can the requirements of combustion most readily be met, for it is manifest that in order to maintain constant steam pressure with varying fuel conditions there must be comparatively great and rapid changes in the draft.

The chimney as a means of creating movement of air depends upon the heating of that air, by which a difference in density is produced. The heat thus employed is, however, absolutely wasted so far as its utilization for other purposes is concerned. Any attempt to extract more of the heat from the gases as they escape from the boiler must with a given chimney result in a reduction of the draft. The loss under various conditions is made evident in Fig. 5. This inherent loss actually amounts to about 20 percent with ordinary coal, when the gases are at 500 degrees and the excess of the air is 100 percent. Reduction in the loss of heat in the escaping gases may be secured by decreasing the volume of air supplied in excess of that chemically required, and by providing means for the abstraction of heat from the gases after they leave the boiler.

The loss resulting from the supply of air in excess of that necessary for perfect combustion is twofold in its character:

First, the excess of air entering the furnace is heated by

the burning fuel, thereby lowering the temperature of the mixture of gases and air below that which would prevail if the gases only were present. As a consequence, the rate of absorption of heat by the water is reduced, for it is dependent upon the difference in temperature between the water and the gases.

Second, owing to larger volume and higher velocity, there is less time to part with the heat. As a consequence, the temperature of the mixture of gases and air escaping to the chimney is higher than would be the case if there were no excess of air; while the increased volume is such that the total amount of heat thus carried away, without exerting any useful effect, is greatly increased. In other words, paradoxical as it may seem, the larger the volume of air supplied the higher will be the temperature of the escaping gases, within the ordinary range of boiler practice.

Intimate distribution of the air through the fuel is manifestly essential to perfect combustion. For such intimacy of contact intense draft and a clean and reasonably thick fire are necessary; conditions which may be most readily maintained by means of mechanical draft. The relation of draft to the rate of combustion in a horizontal return tubular boiler, with or without retarders in the tubes, is indicated by Table III.

With a thick fire, the air is compelled to come in contact with a greater amount of fuel, and is afforded a better opportunity to promote perfect combustion. This points to the supply of decreased volumes of air with higher rates of combustion. Table IV. shows results secured by J. M. Whitham in tests with a Wilkinson stoker in stationary practice.

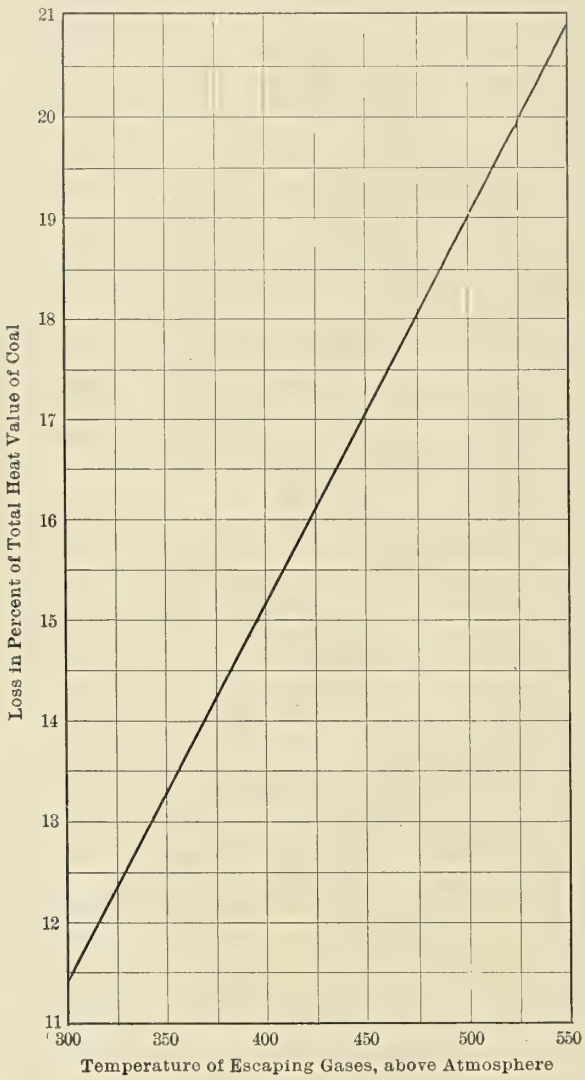


FIG. 5.—LOSS OF EFFICENCY DUE TO TEMPERATURE OF ESCAPING GASES ABOVE ATMOSPHERE, WITH 100 PERCENT EXCESS AIR.

TABLE III.—RELATION OF DRAFT AND RATE OF COMBUSTION.

Pounds of Dry Coal burned per Hour per Square Foot of Grate.	Furnace Draft	Resistance, in Inches of Water, Due to			Total Draft in Inches of Water.			
					No Return Pass		With Top Pass	
		Pass under Boiler & through Tubes.	Retarders in Tubes.	Pass over top of Boiler	No Retarders.	With Retarders.	No Retarders.	With Retarders.
5	0.04	0.04	0.00	0.04	0.08	0.08	0.12	0.12
10	0.13	0.07	0.03	0.05	0.20	0.23	0.25	0.28
15	0.20	0.11	0.03	0.05	0.31	0.34	0.36	0.39
20	0 24	0.16	0.08	0.06	0.40	0.48	0.46	0.54
25	0.27	0.22	0.19	0.06	0.49	0.68	0.55	0.74
30	0.30	0.27	0.31	0.07	0.57	0.88	0.64	0.95
40	0.36	0.38	0.46	0.08	0.74	1.20	0.82	1.28

TABLE IV.—AIR SUPPLY WITH DIFFERENT RATES OF COMBUSTION ON A WILKINSON AUTOMATIC MECHANICAL STOKER.

Buckwheat Coal burned per hour per Square Foot of Stoker Grate. Pounds.	Air to burn One Pound of Buckwheat Coal.		Percentage of Excess or Deficiency of Air Supplied.
	Theoretically Req'rd Cubic Feet.	Actually Supplied Cubic Feet.	
12.0	125	232	+ 85.6
18.0	125	157	+ 25.6
25.2	125	132	+ 5.6
32.5	125	123	— 1.6
41.5	125	111	—11.2
45.4	125	111	—11.2

Tests upon a marine boiler have shown that with a constant combustion rate of 27 pounds the water evaporated per pound of coal from 212° increased from 10.77 pounds with a 9-inch fire, to 11.54 pounds with a 14-inch fire.

(To be concluded.)

Another Brazilian Liner.

We present photographs of the steamship *Para*, a Brazilian liner built by Workman, Clark & Company, Limited, Belfast, one of nine vessels of various types to be built by them for the Lloyd Brazileiro of Rio de Janeiro, and a sister ship of the *Ceará*, described at page 404 of our October, 1907, number. The *Para* is 354 feet in length, with a gross tonnage of over 3,500 tons, and has been built to the highest class in Lloyd's Register, besides fulfilling all the requirements of the British Board of Trade for foreign-going passenger steamers. In general design and arrangements, the vessel has also been made to conform to the requirements of the passenger and general cargo trade of the South American coast.

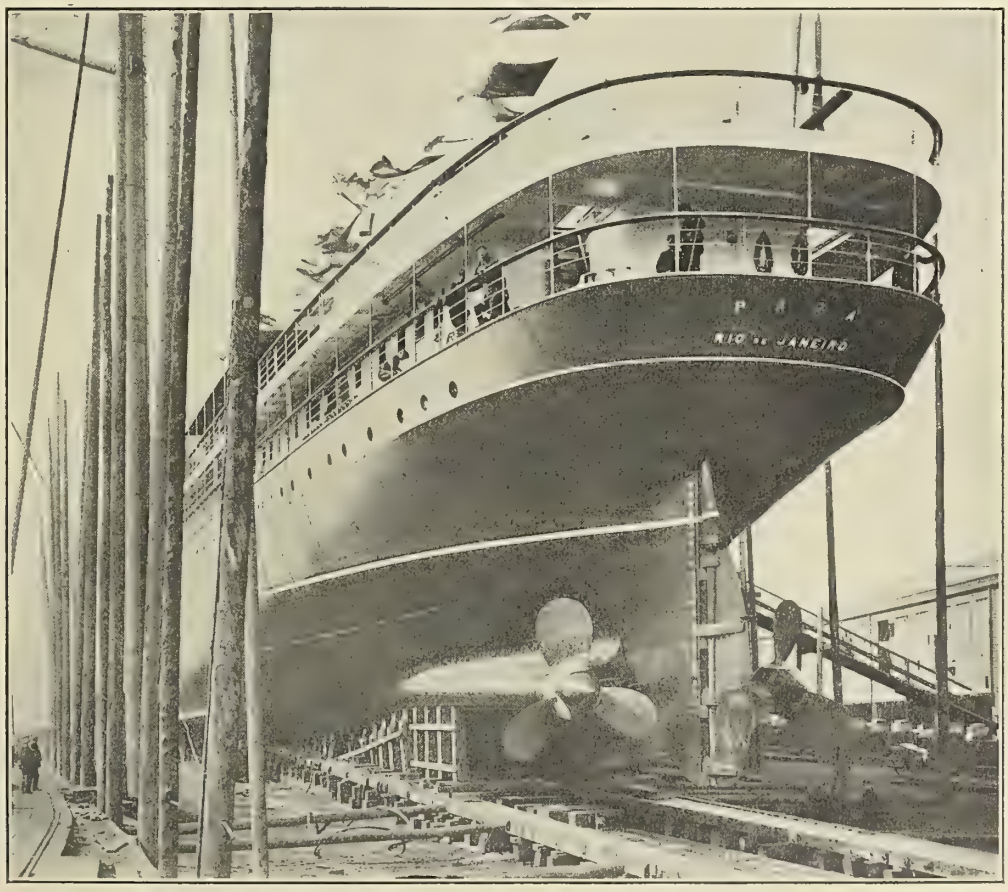
Each of four holds, into which the cargo space is divided by watertight bulkheads, is provided with hatchways, equipped with powerful hydraulic cranes, capable of rapidly loading and discharging cargo. Baggage and parcel rooms are provided for the stowage of passengers' luggage and mail, and bullion rooms are also fitted up.

The propelling machinery and boilers were constructed by Workman, Clark & Company, and consist of two sets of triple expansion engines, with all the most recent improvements, and three steel cylindrical multitubular boilers, working under Howden's system of forced draft. Steam for the auxiliary engines and deck machinery is supplied by an auxiliary boiler.

Accommodation is provided for 170 first class passengers, 20 second class and 300 third class. The rooms for the first class passengers are on the upper and main decks, and in addition to the ordinary staterooms, a number of *cabins de luxe*

THE BRAZILIAN STEAMER PARA ON TRIAL TRIP.

are provided; these suites consist of a sitting room, bed room, bath room and lavatory. The first class dining saloon, on the main deck, is a large, roomy and well lighted apartment extending the full width of the vessel. From this saloon a wide staircase leads to the main entrance hall on the upper deck, which is fitted up as a lounge. Opening off it are the *cabins de luxe* and principal stateroms; and a broad central corridor runs fore and aft, with staterooms opening off on each side. Large double doors on each side of this entrance hall open on to the deck. The main staircase continues from this deck to the entrance hall on the shade deck. The forward end of this hall opens into the music saloon, and at the

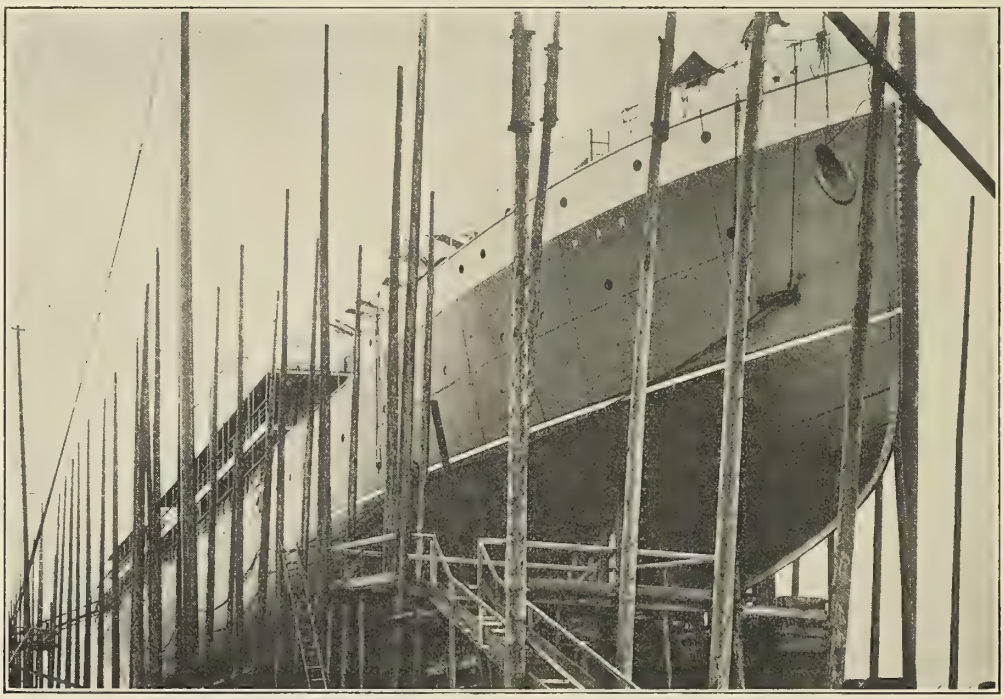


THE STERN OF THE PARA JUST PREVIOUS TO LAUNCHING, SHOWING THE WEB STRUTS.

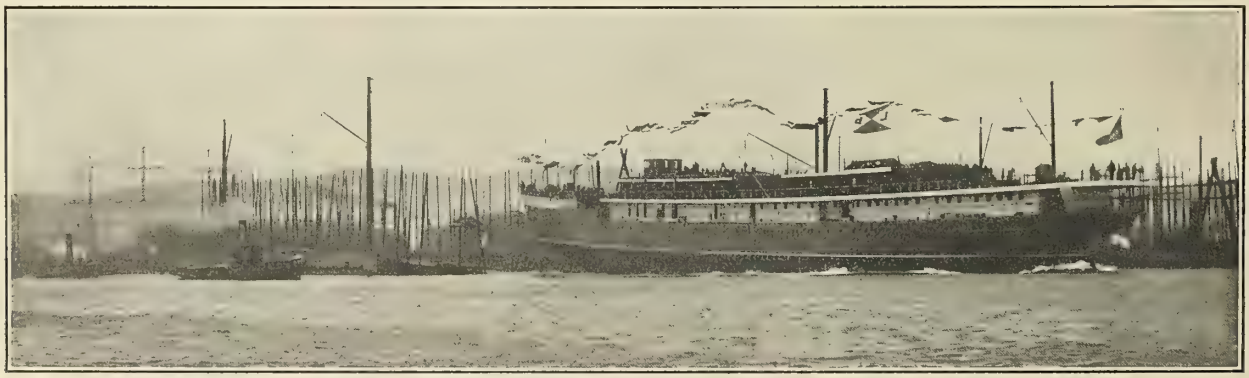
THE SHIP AFLOAT AFTER LAUNCHING, AND READY FOR RECEIVING MACHINERY AND FITTINGS.

after end is the smoking room. Both of these rooms are lofty and well lighted apartments, handsomely furnished. Double doors on each side of the entrance open on to the shade deck, which affords ample promenading space. On this deck are additional first class staterooms, and the officers' rooms have been placed in a deck house at the forward end of the funnel casing, below and abaft the pilot house.

The second class accommodation is arranged on the main deck forward of the boiler room, and includes a large central dining saloon, with staterooms opening off alleyways on each side of the saloon. The steerage quarters are at the forward end of the main deck, and include a separate apartment for women. The remainder of the space is fitted up with iron beds and hammocks.



THE BOW OF THE PARA SHOWS GRACEFUL LINES AND A GENEROUS FREEBOARD.

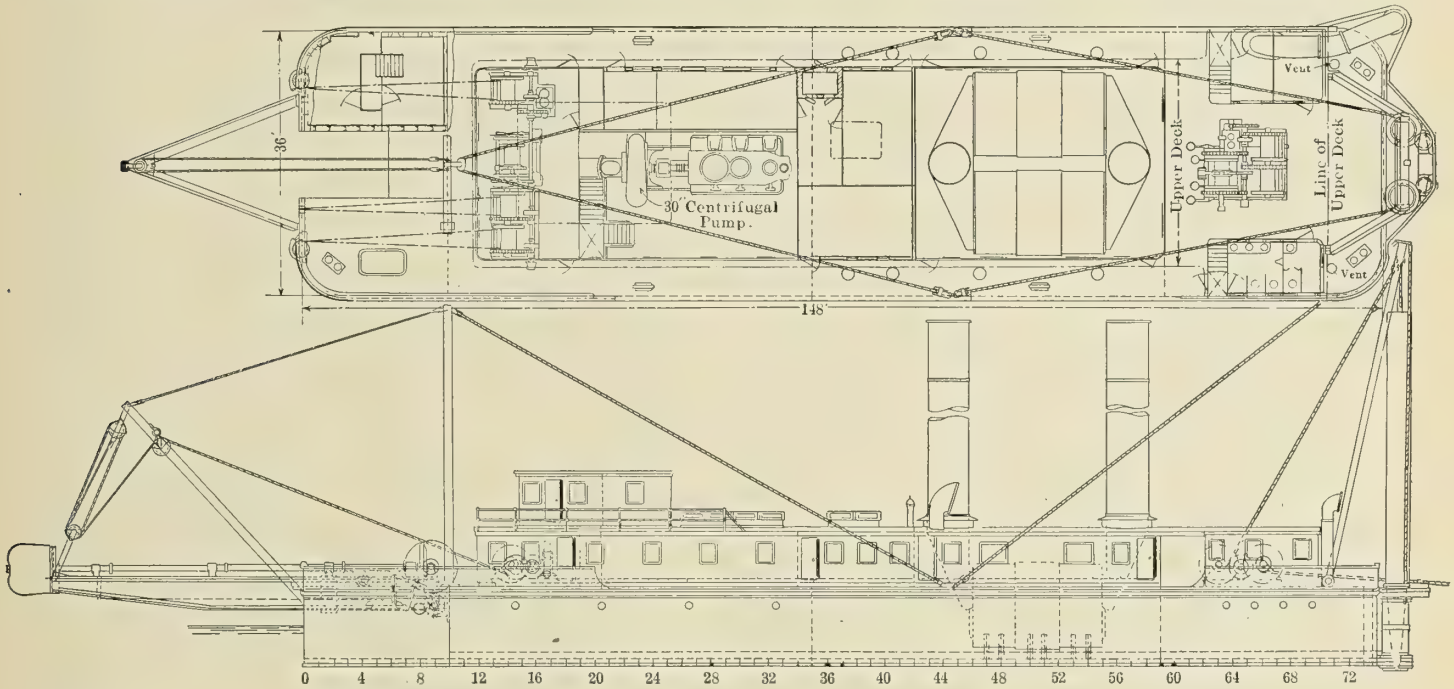


THE BRAZILIAN STEAMER PARA TAKING THE WATER AT THE YARD OF WORKMAN, CLARK & COMPANY, LIMITED.

The engineers' and petty officers' rooms are in the 'midship house on the upper deck, and the top-gallant fore-castle is arranged for the accommodation of the crew. An efficient system of natural and artificial ventilation is arranged throughout all the living and public rooms, and the sanitary arrangements have received special attention. The galleys and pantries are supplied with all modern appliances. The auxiliary machinery includes patent fire-extinguishing apparatus, also Welin quadrant davits. Benjamin Taylor.

A Large Hydraulic Dredge.

The dredge *Francis T. Simmons* is a large and powerful machine built to the order of the commissioners of Lincoln Park, Chicago, for the purpose of filling in the new park extension to the north of the present park. The plan is to reclaim from Lake Michigan an area approximately 1,500 feet wide by about a mile long, by inclosing it with a stone revetment or breakwater, and filling in behind this with material taken from the bed of the lake. For much of the distance the breakwater lies in 18 feet of water, and the total volume of fill is about 4,000,000 cubic yards. The breakwater is now partly completed and is made of stone from the spoil-banks of the Chicago drainage canal. A fleet of large scows and several powerful tugs are employed to bring the stone from the canal by way of the Chicago river, out into the lake, and so to the site of the work.



ELEVATION AND GENERAL DECK PLAN OF HYDRAULIC DREDGE FRANCIS T. SIMMONS.

The conditions surrounding the dredging and filling of this work were difficult and peculiar. Not only was the locality in deep water and exposed to the storms of Lake Michigan, which often rise with suddenness and severity, but the soil to be dredged consisted of the tough blue clay which underlies the Chicago area, compacted by the storms of the lake, and mixed with more or less gravel and stones. The ordinary hydraulic dredge as used on the lakes would therefore be unsuitable, both because of unseaworthiness and because it could deal effectively only with soft material. The usual floating pipe-line connected by rubber sleeves and mounted on a number of small scows or floats would be put out of business with every wind storm, or irretrievably wrecked.

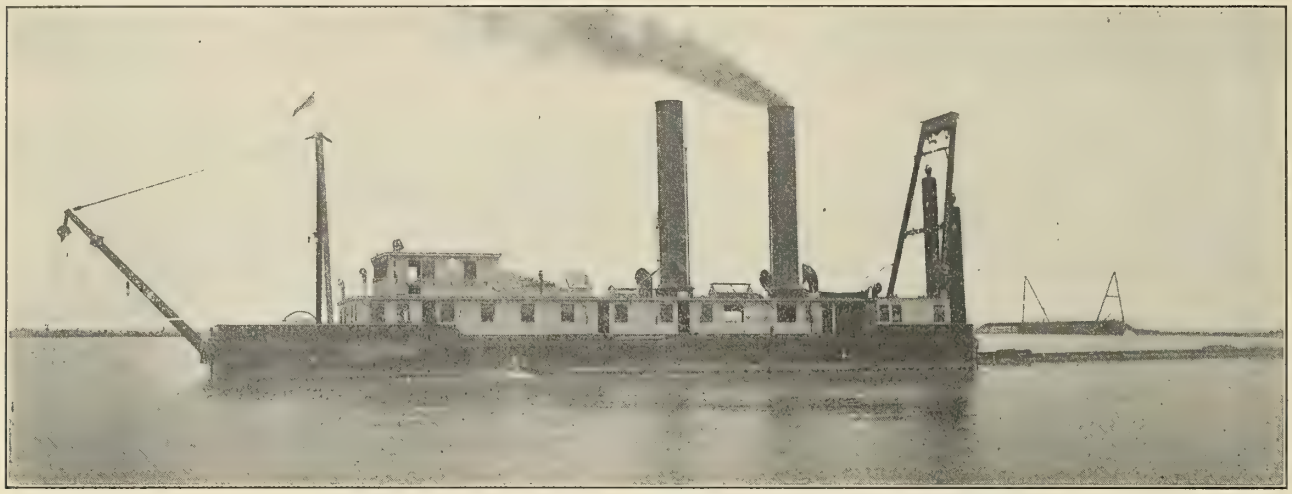
The superior economy of the hydraulic process of dredging and filling, if it could be successfully applied, led the commissioners to apply to A. W. Robinson, A. S. C. E., of Montreal, who had previously designed and built several large hydraulic dredges, notably the *Tarte*, which is employed in dredging clay from the bed of Lake St. Peter, in the River St. Lawrence, and which is provided with a special pipe line for withstanding heavy storms. This dredge is of great power, and holds the world's record for output, having dredged 750,000 cubic yards in a calendar month and delivered it at a distance of 2,000 feet. The original pipe line of this dredge is still in use, after having withstood the storms of five years.

It was, of course, realized that Lake Michigan in its angry moods would be too rough to attempt continuous dredging operations, and that the most that could be done would be to provide a plant of large capacity, so that the required output could be made after making allowances for weather interruptions, and also seaworthy enough to increase the working time to the largest possible amount. It should also be designed for safe and rapid picking up of anchorages and pipe line in case of storm, and to safely withstand any stress of weather when not working.

To meet these conditions Mr. Robinson designed the present dredge, which was built by the Atlantic Equipment Company, 111 Broadway, New York, and put in service in June, 1907.

The hull is of steel, 148 feet long, 38 feet wide and 10 feet 6 inches deep. The frame spacing is 24 inches. The main pump has 30-inch suction and discharge, and the main engines are of the triple expansion marine type, of 1,200 indicated horsepower, built by the Neafie & Levy Ship & Engine Building Company, Philadelphia. This engine has cylinders 17, 27 and 44 inches in diameter, with a stroke of 24 inches. There are two double-ended marine boilers, built by the Manitowoc (Wis.) Dry-Dock Company, 11 feet 6 inches diameter by 18 feet long, with eight corrugated furnaces. The installation of engine room auxiliaries, such as condensing apparatus, pumps, electric lights, etc., is most complete and well arranged, the engine-room space, in fact, resembling that of a small ocean liner.

On the upper deck is a pilot house with large plate glass windows, where are arranged all the levers which control the

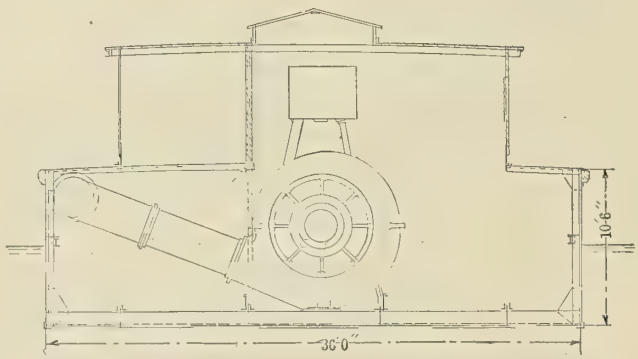


THE HYDRAULIC DREDGE FRANCIS T. SIMMONS AT WORK IN LAKE MICHIGAN.

operation of the dredge. Here are also pressure and vacuum gages for all purposes, indicating exactly the work that is being done.

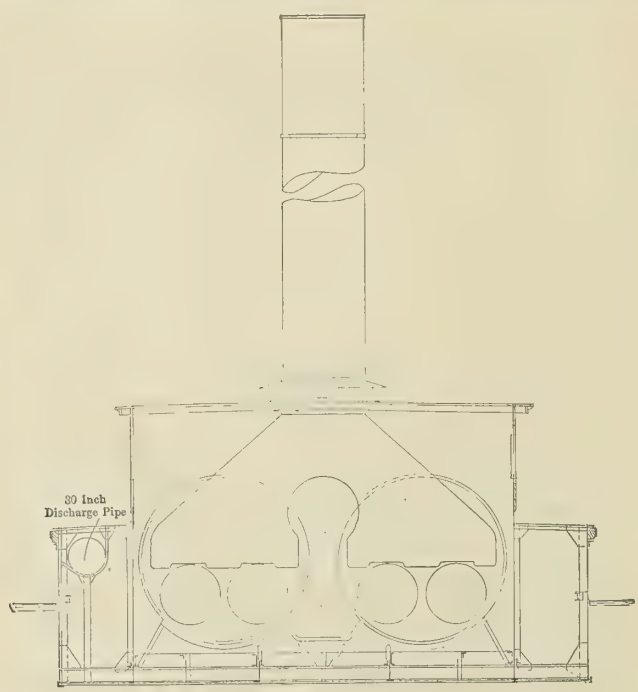
The suction pipe is carried by a very strong steel frame, and is fitted with a powerful cutter for digging the clay. This cutter is an improved development of a number of earlier machines, and has demonstrated its efficiency by being able to handle the heaviest clay up to the full capacity of the pump. It is 9 feet in diameter, and weighs about nine tons, being formed of eight steel blades of peculiar curvature cast in one piece, and having renewable hard steel cutting edges attached. The mechanism for driving and feeding this cutter is of the most powerful description. The secret of success of this dredge is that the excavation of the stiff clay is done by an efficient cutting tool that will not clog, and provided with a powerful feed, the main pump being employed only for transportation of the spoil. A capacity rate of 3,000 cubic yards per hour has frequently been reached in clay, the entire under side of the discharge appearing as continuous slices of blue clay, some of the pieces being four or five feet long.

One of the most serious problems to be dealt with was that of the floating pipe line. This is the most seaworthy pipe line on the lakes, and is formed of semi-submerged steel pontoons about 100 feet long, connected by ball-and-socket joints, having spring connections of great strength. Long lengths of pontoon were necessary to give steadiness in waves, and a yielding connection was essential to relieve the joints of the great stresses due to surging. The springs are of locomotive draw-bar size, and are arranged similarly to



SECTION AT FRAME 20, LOOKING AFT, SHOWING CENTRIFUGAL PUMP.

THE PONTOONS AND PIPE-LINE SUPPORTS.



SECTION AT FRAME 42, LOOKING AFT, SHOWING BOILER PLANT.

railway car draft rigging. There are also tension and compression springs to control the side deflection of the joint. In wave action this pipe line is very satisfactory. A special flange connection is provided at the dredge, so that the pipe line can be instantaneously disconnected from the dredge at any time, simply by pulling out a toggle lever. On several occasions, when it became too rough for the dredge to work, owing to the difficulty of discharging over the breakwater, the pipe line was disconnected and towed to harbor by a tug, through a rough sea which broke over both tug and pipes continuously, with no harm whatever to the pipe line. These occasions, however, are relatively rare, and the operation of the dredge has proved not only that the clay of the bed of Lake Michigan can be dredged by this method, but also that the seaworthiness of both dredge and pipe line is sufficient to reduce the delays on account of weather to a comparatively small amount.

The cost of the dredge was $148,000 (£30,412). When at work, it is held in position by two spuds, 45 feet long, with steel tips weighing 12 tons each. The dredge is not self-propelling.

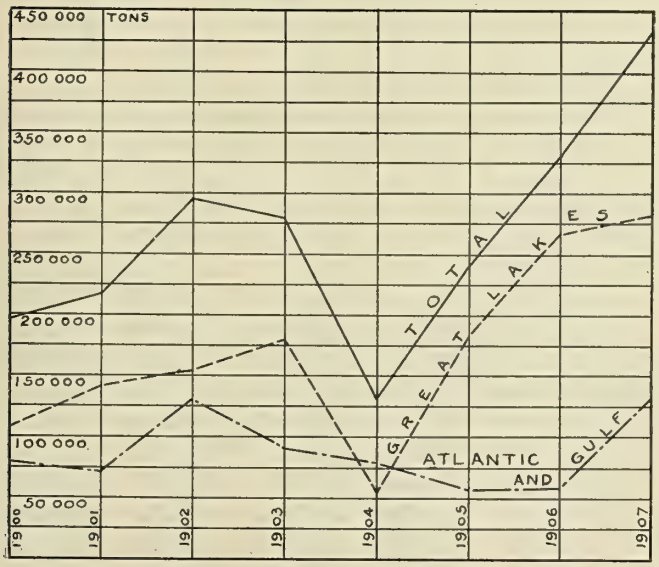
Shipbuilding in the United States.

The Bureau of Navigation of the Department of Commerce and Labor reports the construction in the United States during the calendar year 1907 of 1,056 merchant vessels aggregating 502,508 gross tons, as compared with 1,045 vessels of 393,291 tons in 1906, and 1,054 vessels of 306,563 tons in 1905. The

MERCHANT VESSELS BUILT IN THE UNITED STATES.

Year.	Ships.	Gross Tons	Average Tons.	Great Lakes Ships.		
				Gross Tons.	Per-cent.	Average.
1900.....	1,102	365,791	332	129,973	35.6	1,476
1901.....	1,322	376,129	284	156,157	41.5	1,270
1902.....	1,270	434,005	342	158,230	36.5	1,521
1903.....	1,159	381,970	330	182,593	47.8	1,438
1904.....	1,063	265,104	249	54,042	20.4	819
1905.....	1,054	306,563	291	182,361	59.5	1,736
1906.....	1,045	393,291	376	268,085	68.2	2,197
1907.....	1,056	502,508	476	283,492	56.4	2,100

gain is very marked, being about 28 percent. This tonnage is greater than that of any year since 1855, which showed 583,450 tons. The only other year in the history of American shipbuilding when the figure exceeded 500,000 tons was in 1854, with 536,046. In both these cases more than 83 percent of the tonnage was in sailing vessels, whereas of the present year's figures the sailing tonnage amounts to only 29,324, or 5.8 percent.



STEEL STEAMSHIP TONNAGE BUILT IN THE UNITED STATES.

Of the total for the year, not less than 135 vessels of 283,492 tons are accounted for by the Great Lakes. This represents 56.4 percent of the total tonnage, which is a falling off in percentage as compared with the two previous years, although the total lake tonnage has increased. The healthy increase of 93,810 tons (from 125,206 to 219,016 tons) on the coasts is very encouraging, consisting, as most of it does, in steel steamers (gain 88,627 tons, from 61,528 to 150,155 tons). The tables and diagram give the results since the beginning of 1900.

STEEL STEAMERS BUILT IN THE UNITED STATES.

Six Months Ending.	Totals.		Atlantic and Gulf		Great Lakes.	
	Ships.	Gross Tons.	Ships.	Gross Tons.	Ships.	Gross Tons.
June 30, 1900...	52	105,713	31	34,803	17	63,885
Dec. 31, 1900...	40	91,244	20	44,179	16	44,626
June 30, 1901...	64	144,021	31	46,297	30	91,994
Dec. 31, 1901...	40	74,604	21	25,541	17	49,020
June 30, 1902...	74	196,197	34	76,186	32	109,019
Dec. 31, 1902...	42	98,516	26	52,385	12	43,248
June 30, 1903...	69	153,389	33	54,411	29	88,412
Dec. 31, 1903...	50	126,392	20	36,077	28	89,562
June 30, 1904...	43	113,261	27	61,904	13	50,336
Dec. 31, 1904...	31	19,472	25	16,955	5	2,498
June 30, 1905...	42	139,883	17	39,822	24	99,999
Dec. 31, 1905...	51	100,127	27	18,843	21	80,932
June 30, 1906...	58	181,614	25	24,378	31	156,792
Dec. 31, 1906...	56	146,177	33	35,895	21	109,471
June 30, 1907...	66	214,488	38	75,564	26	129,242
Dec. 31, 1907...	69	216,181	34	53,167	31	151,272

New Steamship Lines.

The Archaia Steamship Company and the Austro-Americana Steamship Company have made an arrangement whereby the former will operate steamers from Smyrna and neighboring ports in the Grecian Archipelago to Patras, in time to catch steamers of the latter line sailing from Patras via Trieste every ten days to New York and New Orleans alternately. All of the vessels are fitted for handling both passengers and cargo. The sailing time from Patras to New York is about fourteen days, and to New Orleans about the same. This latter port is a new departure for steamship companies trading with the levant.

Two lines which recently began operation between Rotterdam and New York, carrying freight and steerage passengers, are the Russian Volunteer Fleet, with an aggregate of 26,774 tons in four vessels, and the Russian East Asiatic Steamship Company, with four vessels, amounting to 19,283 tons. The largest vessel in each fleet can carry about 1,300 passengers. All sail under the Russian flag, and have headquarters at Libau. The service is fortnightly in each case.

A new service is being started between New York and the east coast of South America by the Lamport & Holt Line, sailing under the British flag. Steamers are to be sent out semi-monthly, the first of the new class being the *Verdi*, leaving New York January 20, 1908. The ships will run to the Plata in about twenty-one days, including stops at Bahia, Rio de Janeiro and Santos. Owing to difficulty in obtaining satisfactory coal in South America, these vessels have to carry enough from New York (3,100 tons) to make the round trip.

A new line is to be started in the near future between Trieste, Austria, and Charleston, S. C. Regular service is to be established for the carrying of both freight and passengers.

The Compagnie Générale Transatlantique is about to divert from New York to Montreal some of the older of the ships now visiting the former port. This will make regular service from Havre, and will be in direct competition with some of the Allan Line steamers.

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Shipbuilding in the United States.

The tables and diagram in another column show a very decided increase for the year 1907, as compared with previous years, in American shipbuilding. It frequently happens that when such an increase is noted, for any one year over a previous year or series of years, the gain is found to lie almost wholly in the shipbuilding on the Great Lakes. This time, however, a change has occurred, for the gain on the Great Lakes is only a small percentage of the total gain for the year. It happens that there have been a considerable number of large coastwise steamers built during the past year, and a few for off-shore trips, such as those to Hawaii and Cuba. Many of these vessels have exceeded 4,000 tons in measurement, and the result has been a very great increase, as compared with the previous year, in the construction of steel steamers for salt water use. As shown in another column, this last mentioned increase, from 61,528 to 150,155 tons, represents a gain of 88,627 tons, or not less than 144 percent.

If there were orders or inquiries in hand which might give rise to a reasonable expectation that this state of things would continue, the situation would be decidedly encouraging. Unfortunately, however, the boom, if such it might be termed, appears to have been wholly of a temporary character, and it is more than likely that the year 1908 will show a very decided falling off as compared with 1907, even though it may possibly exceed the figures for 1906 and for the previous years. American ship owners and shipbuilders are looking earnestly to Congress for some action which would place the United States merchant fleet upon some sort of a parity with the merchant fleets of many of the other countries, particularly in the way of postal subsidies. If such action is taken, it is practically certain to result in a decided increase in the number of vessels built, and it is practically certain that some of these would be for foreign service, particularly between the United States and some of the South American countries.

This is a proposition which has frequently come up for consideration, and a year ago such a bill was actually passed by both Houses, but the Representatives made such radical alterations in the original Senate bill that when it got back to the Senate for confirmation, it was "talked to death." The measure has many powerful enemies, and many friends. The main features comprise mail subsidies to lines of regular steamers to various South American ports, with certain conditions as to speeds, extent of service, and other points; and, of course, all must fly the American flag and be built in the United States. It is confidently expected that the passage of some such bill would act as a substantial stimulant to the shipbuilding industry—and particularly the most important part of it—that concerned with the construction of large ships. An argument of considerable potency was found in the recently developed inability of the American merchant marine to provide a sufficient number of suitable ships to act as colliers for the battleship squadron, now *en route* to the Pacific coast.

The New York Motor Boat Show.

The show which was held in the Grand Central Palace from Dec. 7 to Dec. 14, 1907, was notable in many respects. The great variety of the exhibits and their general quality of interest drew a very large crowd to the afternoon and evening sessions, while the demonstrations in the morning and afternoon gave food for much thought to those who attended the show for the serious purpose of looking into the subject from the point of view of prospective purchasers.

Particularly prominent were the smaller types of boats, with engines of from 1 to 10 horsepower, and speeds from 5 to 8 miles per hour. The prices marked on boats of this character were, in many cases, surprisingly low, due largely to their being turned out to

identical patterns in considerable numbers—manufactured, in other words—and to the fact that standardization, particularly in the engine department, has brought about a very substantial reduction in the cost of manufacture during the last two or three years. Boats of this type carry engines of very staunch build—quite different from the light, and in many cases rickety, engines carried by the modern automobile. As a result, the motor-boat engines can be depended upon to operate hour after hour with very little care or adjustment, as compared with which many of their sister type are continually getting out of order. The staunch construction carries with it, of course, a considerable increase in weight, but this is one of the many features which has helped to reduce the cost of production, inasmuch as the extremely light motors of the other type require the utmost refinement in design, material and workmanship, and in many cases an extremely low value for the factor of safety.

There were not present this year so many boats of the very large and expensive type as were exhibited a year ago, but those that were there were of a healthy, substantial design, some of them being intended for work in rough water at a moderate speed, and others for high-speed operation on rivers, lakes and such inclosed bodies of water as Long Island Sound. The main object of all of these designs seems to have been the provision of maximum comfort in minimum space, there having been only one boat exhibited which was greater than 35 feet in length.

Aside from the boats, there were scores of engines of all sizes and types, from the smallest up to as much as 75 or 100 horsepower, and a great variety of what might be termed auxiliary appliances, such as small dynamos for lighting, or other electrical purposes, devices for measuring speed, searchlights, propellers of both the solid and the reversing type, reversing gears, and the innumerable odds and ends that go to make up the sum total of the outfit of a modern motor boat.

Modern Marine Transportation.

The article under the above heading, which we are concluding this month, brings up a subject which in many of its component parts has been under contemplation by various engineers for some time. The entire assemblage, however, of these parts into one harmonious whole, and their development into working shape, is a new departure, and is one which bids fair to have a considerable future ahead of it. The whole thing is delightfully simple from the point of view of operation, and very much can be said in its favor. It has not, however, as yet had a practical demonstration, and, until that comes, we cannot say with much certainty just what the ultimate outcome is to be.

The proposition to keep the power part of the equipment almost continuously in operation is thoroughly sane, it being a well recognized fact that under present conditions very many steamers are stationary considerably more than one-half of their time, even though they may be considered as busy vessels, and may be continually supplied with work. By laying up, however, for loading and unloading, only that part of the equipment comprised by boats carrying cargo, but not carrying the main prime movers of propulsion, we are getting full returns from the power plant, and a consequently much reduced interest and stand-by charge per unit of work performed.

The financial statement worked out in the present number has been based entirely upon conditions as they exist to-day along the north Atlantic coast of the United States. The figures have been obtained from thoroughly competent and reliable sources, and we are informed that they may be depended upon with entire certainty. The saving of the electric unit system as compared with the ordinary system, in which a single steamer is used to perform the entire work now proposed for a fleet of barges, is very marked. Of course the figures do not in any sense represent the profits which might be expected in either case from the operation of either the steamer or the fleet. They do, however, represent relative figures in a sufficiently exact way to render such a comparison of considerable value in connection with the formation of a program for carrying into effect the provision of such a fleet for the purposes outlined.

The alternative suggestions made for the use of part of the power are interesting, involving, as they do, under certain conditions, the provision of refrigeration, electric lighting, electric hoisting and various other functions, all from the one main source of energy located in the power boat. The use in these cases of absolutely standard equipment, such as can be purchased at any time in the open market, would make it perfectly easy, when one vessel happened to be tied up to shore for the purpose of discharging or taking on cargo, or for any other purpose, to make proper electric connections, and thus continue all these functions without more than momentary cessation while the connections are being made. In this way transportation of perishable fruit products, necessitating the use of mechanical refrigeration, could be carried out with perfect safety to the cargo, and with a reasonable expectation that it would be found upon delivery to be in good shape.

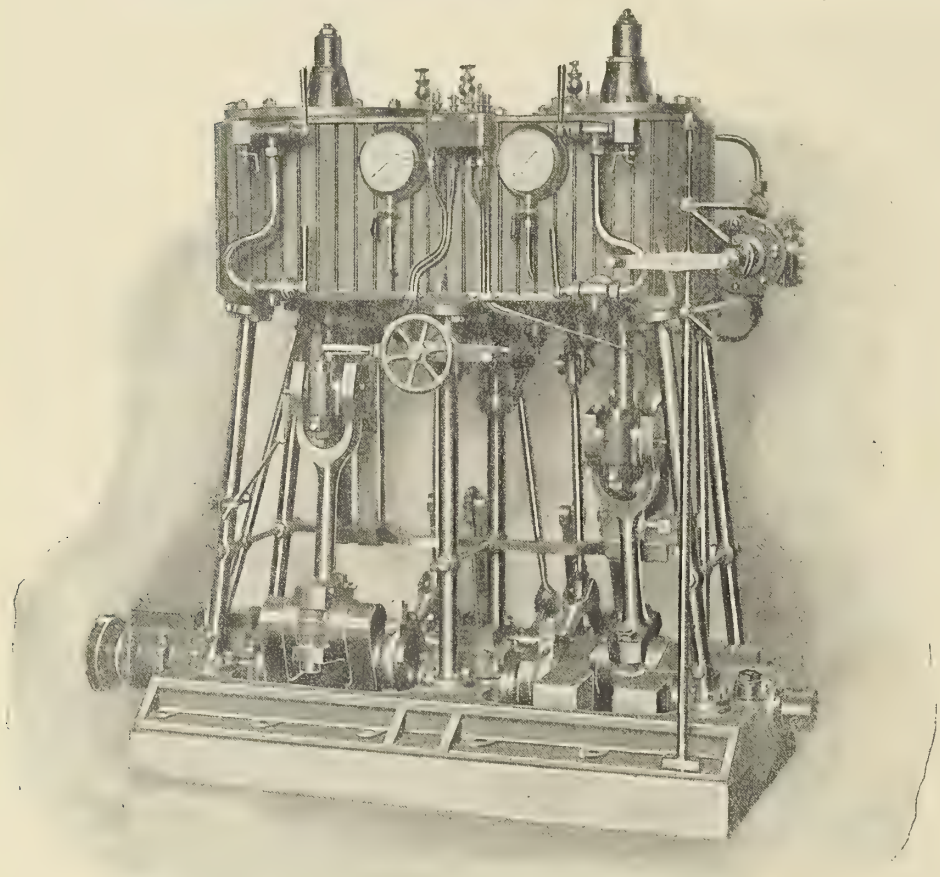
The whole proposition is one which certainly merits a practical investigation and demonstration of its capabilities, and it is to be hoped that some enterprising manager of a transportation line will see fit in the not distant future to give it a thorough trial. It is a system which, once started, would readily lend itself to indefinite expansion, and hence, if it should prove even half as successful as its promoter expects, there should be a steady increase, after once the entering wedge made itself manifest as a dividend earner.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports, Dec. 10, 1907, the following percentage of completion of vessels for the United States Navy:

	Tons.	Knots.		Nov. 1	Dec. 1.
BATTLESHIPS.					
Mississippi	13,000	17	Wm. Cramp & Sons	96.82	98.01
Idaho	13,000	17	Wm. Cramp & Sons	89.41	91.24
New Hampshire	16,000	18	New York Shipbuilding Co.	90.2	93.1
South Carolina	16,000	18½	Wm. Cramp & Sons	28.83	31.68
Michigan	16,000	18½	New York Shipbuilding Co.	29.1	33.5
Delaware	20,000	21	Newport News S.B. & D.D.Co	2.33	5.08
North Dakota	20,000	21	Fore River Shipbuilding Co.	4.23	7.84
ARMORED CRUISERS					
North Carolina	14,500	22	Newport News Co.	93.33	95.17
Montana	14,500	22	Newport News Co.	87.38	89.49
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	92.7	94.
Birmingham	3,750	24	Fore River Shipbuilding Co.	90.79	91.88
Salem	3,750	24	Fore River Shipbuilding Co.	88.52	90.29
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co.	99.	99.

ENGINEERING SPECIALTIES.



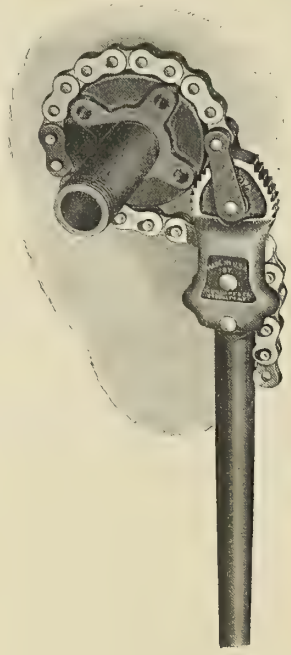
Small Steam Yacht Engines.

Messrs. W. Sisson & Co., Ltd., Gloucester, have confined themselves chiefly to high speed, high class machinery for yachts, launches, tug boats, passenger and small cargo vessels, and also make a specialty of small side and stern paddle wheel machinery.

The illustration shows a compound non-condensing engine of 280 indicated horsepower, fitted in the Windermere launch *Elfin*, and giving her a speed of 24½ statute miles per hour. This engine is supplied with steam from a loco-marine type boiler, at 190 pounds working pressure. The valve gear is of their specially designed single fixed eccentric or "elliptic" type, all the working joints being made adjustable. This type of valve gear is said to be much superior to the ordinary link motion, there being no sliding working parts, but pin joints, which are easily adjustable for wear. Ample surface is provided throughout, and as it is a very easy working gear, it will run a long time continuously without needing adjustment. It is also said to give a better steam distribution than the link motion, and is very easily handled.

"Agrippa" Fittings Wrench.

A drop-forged wrench for use on pipe fittings, which gets into the tight, narrow places and bites on irregular surfaces where a broader chain wrench would fail, is being placed on the market by J. H. Williams & Company, 150 Hamilton avenue, Brooklyn, N. Y. It is claimed that this wrench greatly reduces the trouble and annoyance which is always occasioned when handling short nipples and flange connections, or jobs with a variety of outlets. The wrench has a narrow, powerful jaw for both pipe and fittings. The "Agrippa" wrench is the outcome of the Vulcan chain pipe wrench, which has stood the test of many years' service.



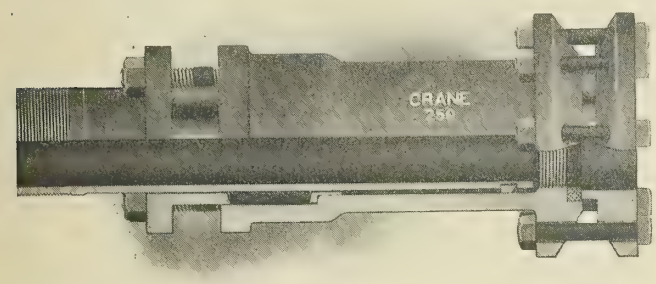
This wrench is made of all wrought steel with drop-forged jaw given a soft temper, and permanently fastened in a milled pocket to a solid, forged-steel handle. The chain is longer than in wrenches made for pipe only, so that it may easily take in large fittings, and is hand made so that there is no danger of flaws. This chain swings from the center, and can be used on either side of the jaw.

A New Expansion Joint for Ammonia.

The practice of providing for expansion and contraction in ammonia work is increasing, particularly on long lines. A

device for this purpose which is well adapted for marine work, on account of its compactness, is the expansion joint which has recently been placed on the market by the Crane Company, Chicago.

This device consists of a semi-steel body, with a sleeve made of extra heavy wrought pipe. To prevent the joint from pulling apart the sleeve is recessed near the end, and a split ring

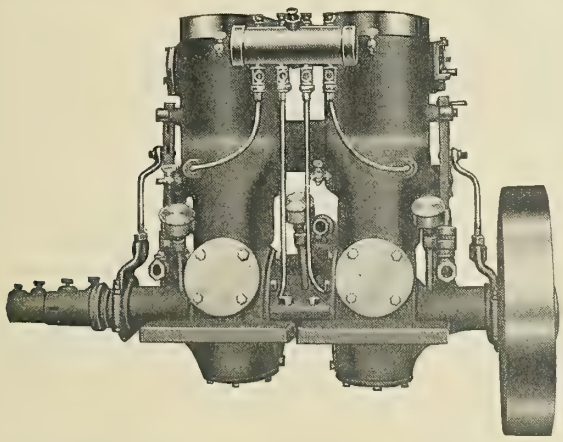


inserted. Should the line give way, this ring cushions against the bushing in the bottom of the stuffing box, thereby holding the sleeve in place. As the gland studs are made very heavy, this construction accomplishes the same purpose as tierods, with considerable saving in space.

The sleeve is threaded to make an ordinary connection. The other connection is made by screwing the pipe into the body, which is recessed to take a square one-piece rubber gasket. The gasket is drawn up with a gland, forming a perfectly tight joint without the use of solder or litharge. The stuffing box is made with generous depth, so that repacking is necessary only at long intervals.

A Two-Cycle Motor.

The Mianus Motor Works, Mianus, Conn., has brought out a new model marine motor for 1908, made from new designs and patterns, but retaining all of the previous features. It is of the two-cycle, two-port, make-and-break type of ignition. One of the strong claims is for extreme good quality. Nickel steel forgings are used instead of ordinary carbon steel, tool steel parts instead of soft steel; cylinders, pistons, piston rings and other parts are ground to a perfect fit; in



fact material and workmanship are said to be fully equal to motors used on high grade automobiles.

To take care of a constantly increasing business, the builders have just completed a new machine shop, built entirely of concrete and steel. Power is supplied by a 60-horsepower gas producer. The new shop will enable them to more than double their present capacity.

TECHNICAL PUBLICATIONS.

Present Day Shipbuilding. By Thomas Walton. Size, 6¼ by 8¾ inches. Pages, 224. Figures, 163. 1907. Philadelphia: J. B. Lippincott Company. Price, $3.50 net. London: Charles Griffin & Company, Ltd.

This work, which is divided into four chapters, is based on Chapters III., IV., VI. and VII. of the author's "Steel Ships," the material having been revised, enlarged and especially arranged to form a complete manual in itself. The preface starts out with the remark that in general the appearance of the hulls of merchant steamers has not changed much in recent years, but that internally very decided improvements and numerous modifications have been made in ship construction. These have been largely in the way of getting rid of obstructions in the holds, such as beams, pillars and cumbersome stringers. It is with this new type of construction that the work particularly deals.

The first chapter is very brief, and is devoted to the classification of ships; the second chapter outlines the principal features and the alternative modes of ship construction; the third and fourth chapters, which are of about one hundred pages each, take up, respectively, types of vessels and details of construction. Under the heading of "types" we have discussions of one, two and three-deck ships; spar and awning deck vessels, and the various modifications of these types, with description and illustration of the principal structural features of many noted ships under these various headings. The details of construction take up the subject in a very comprehensive manner, with great numbers of sketches illustrating the various methods of connecting plates and forming certain portions of the ship's structure. The riveting, butts, frames, floors, beams, keelsons and stringers are given close attention, while the work goes then into miscellaneous details, rudders, masts, bilge keels, pumping devices, etc.

The great number of illustrations makes the work particularly valuable, and it is based on the very latest practice in its particular line. Among the illustrations might be mentioned an expansion of the outside shell plating of a large vessel, showing the arrangement of plates, butts, bulkheads and decks.

Sea Terms and Phrases: English-Spanish, Spanish-English. By Graham Hewlett, R. N. Size, 2¾ by 4 inches. Pages, 368. 1908. Philadelphia: J. B. Lippincott Company. Price, $1.25 net. London: Charles Griffin & Company, Ltd.

This is a pocket-sized glossary comprehending marine and general terms in Spanish and English, and is intended for the use of naval, army and merchant marine people who occasionally come into contact with Spanish-speaking nations. The vocabulary has been brought as nearly up to date as possible, but many old sea terms have been retained, as they are frequently found in Spanish literature, and are not well taken care of in the usual Spanish dictionaries. At the end of the work will be found papers of a Spanish merchant ship in Spanish, with corresponding translation into English on the opposite page. Following this is a tonnage certificate or a certificate of measurement, with corresponding translation; also a bill of health, and tables of relative ranks of officers in the Spanish and British navies and armies.

Marine Boiler Management and Construction. By C. E. Stromeyer. Size 6 by 9 inches. Pages, 404. Figures, 452. London and New York, 1907: Longmans, Green & Company. Price, 12s. net ($4.00 net).

This is the third edition of a work which was issued first in 1893. It deals entirely with the return tubular boiler, popularly known as the "Scotch" boiler, this type having stood the test of many years of operation. The main addition in this edition has been along the line of materials and better methods of

working them, due to a better knowledge of their structures and elements. This includes a study of the microscopic structures of various steels, and also a study of gas analysis and its relation to the up-take and funnel.

The work is divided into eleven chapters, the last two of which summarize the boiler rules of Lloyd's Register and the Board of Trade. The other chapters cover, respectively, boiler management, steam and water, corrosion, fuels and combustion, heat transmission, strength of materials, mechanics, boiler construction and design. The numerous illustrations are all in the nature of sketches, showing the various parts and the strains to which they are subjected, and the methods of achieving definite results from given material. The subject of riveting comes up for extensive treatment under the heading of "Boiler Construction." A comprehensive index at the rear of the volume makes it easy of reference.

Engine Room Chemistry. By Augustus H. Gill, Ph. D. Size, 4½ by 7 inches. Pages, 198. Figures, 47. New York and London, 1907: Hill Publishing Company. Price, $1 (4s.).

This little book is designed to place the simple chemistry of the engine room at the command of the progressive type of engineer who wishes to have all the ins and outs of his profession at his finger tips. The aim of the book is to enable the engineer to acquire such knowledge regarding the proper working of his plant as will enable him to save money for the employer, and to increase the efficiency of operation. It makes special point of the qualities of lubricants and of flue gases; also the quality of fuel and feed-water.

It is divided into seven chapters, and includes analyses of fuels, gas and lubricants, as well as a discussion upon boiler scale, pitting and corrosion, and upon the various physical and chemical properties of mineral, animal and vegetable oils. A good index renders it easy of access.

The Mechanical World Electrical Pocketbook for 1908. Size, 3¾ by 6 inches. Pages, 247. Figures, 50. Manchester: Emmott & Company, Ltd. Price, 6d net.

This is a new work of size fitted for the pocket, especially intended for those in charge of electrical plants and machinery, and for power users and others interested in the industrial application of electrical power. Attention has been particularly directed to the mechanical side of electrical engineering, with full discussions of such matters as belt and rope drive, worm gears, rawhide pinions and electrical cranes and pumping; but no attention has been paid to telegraphy, telephony or the details and refinements of electric traction and dynamo design.

The work starts out with a discussion of the various electrical units, going thence into dynamos and motors and methods of distributing electrical energy. Switches, and the care of electrical machines and instruments are given considerable attention, particularly with regard to defects of dynamos and motors. A large number of tables will be found in the book, including wiring, power of dynamos, various mathematical tables, metric conversion factors, etc. Certain of the chapters take up the subject of galvanic and storage batteries, electric measuring instruments, lamps, and a very brief discussion of prime movers. At the end of the work is a diary for 1908. A complete index at the beginning adds much to the value.

List of Merchant Vessels of the United States, 1907. Size, 8½ by 9½ inches. Pages, 408. Washington, 1907: Government Printing Office.

This work is divided into five parts, including sailing vessels, steam vessels, unrigged vessels, loss of American vessels and government vessels. Under the latter heading is a list of the vessels of the United States Navy, giving the main particulars of dimensions, displacements, tonnage, speed and power; the vessels in the quartermasters' and engineer departments of the United States Army; the vessels of the revenue cutter service; of the lighthouse establishment; of the public health and marine hospital service; of the Coast and Geodetic Survey; of the Bureau of Fisheries, and of the Immigration Bureau.

The main part of the work is taken up with lists of all the merchant vessels of the United States, arranged in alphabetical order according to name. These three parts of the work show the official numbers, signal letters, rig, gross and net tonnage, length, beam and depth, crew, the date and place of construction and the home port.

Record of American and Foreign Shipping. Size, 8 by 9½ inches. Pages, 1,190. American Bureau of Shipping, 66 Beaver street, New York. Price, $15 (£3-1-4).

The volume for 1908, which is the fortieth annual issue of this register, is now being delivered to subscribers. The record contains full reports and particulars of 12,347 vessels, ranging from the ketch to the full powered transatlantic liner, and flying the flag of every nation, alphabetically arranged, with much detail as to build, ownership and condition. This information forms the bulk of the annual volume, but it also contains rules for the construction and classification of all classes of vessels, with illustrations and tables of great technical and practical value; revised rules for the construction of machinery and boilers, electric installations and refrigerating apparatus on shipboard.

The volume contains names of vessels which have been changed; list of compound names arranged alphabetically by last word of name for ready reference; list of addresses of prominent shipbuilders, drydocks and marine railways of the United States; list of owners of vessels; all of much value to the shipping interests. The work is approved and indorsed by the important boards of underwriters of the United States, and is accepted by the merchants and underwriters throughout the world as a standard classification of shipping. Supplements to the volume, issued semi-monthly, keep subscribers informed of new vessels constructed during the year, with reports of repairs to old vessels, and other useful information.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 389.—(1) What is the heat value of wood alcohol in B. T. U.? Also of grain alcohol?

(2) What is the greatest velocity that can be imparted to water by steam at 150 pounds pressure by connecting several injectors in tandem? G. C. E.

A.—(1) The heating value of pure or absolute grain alcohol has been differently determined by various investigators, but the values range close about 12,000 B. T. U. per pound. A value 11,664 has been often used. These values must be reduced when the alcohol is not pure, to allow for the amount of water present. Thus we shall have approximately the following values:

Percentage of alcohol by volume.	Heating value per pound, B. T. U.
95	10,880
90	10,080
85	9,360
80	8,630
75	7,920
70	7,200

For pure methyl or wood alcohol the heating value per pound has been determined at about 9,500 B. T. U., or slightly more than three-quarters that of ethyl or grain alcohol.

It may be noted that the small proportion of wood alcohol used in denatured grain alcohol does not seriously affect the heating value of the latter as compared with the pure spirit, especially if certain other substances are added in small proportions, which may tend to counterbalance the loss of heating value due to the use of the wood spirit.

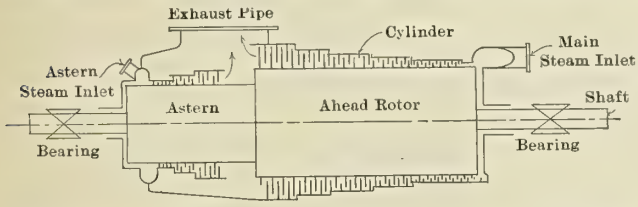
(2) The greatest velocity which can be imparted to water by steam at 150 pounds pressure will depend entirely on the relative proportions in which the steam and water are joined in the mixing chamber of the injector. Steam at this pressure would escape into the atmosphere at a velocity of some 2,800 feet per second. In the operation of an injector a very common proportion is about 12 pounds of water to 1 pound of steam. The combination will then have a velocity of about 215 feet per second. If more water is combined with the steam the velocity will be lower, and if less, it will be higher, up to a maximum of about 2,800 feet per second for a pure steam jet. In general, if x is the number of pounds of water handled by 1 pound of steam, then the velocity of the combination in feet per second will be about $2{,}800 \div (1 + x)$. W. F. D.

Q. 390.—A fore and aft compound surface condensing marine engine, cylinders 20 and 40 inches with 26-inch stroke; boiler pressure 125 pounds and receiver pressure 10 pounds; low-pressure piston has no tail rod, and gives considerable trouble in knocking against cylinder wall in passing top center. This occurs only when the boat is listed or in a seaway; the engine runs smoothly otherwise. The springs hold the piston steady only a short while, when they have to be renewed. Is this due to excessive weight of piston? Please inform me as to the proper construction, weight, etc., of a piston for such service. J. W. P.

A.—It would probably take an examination of the engine to determine the cause of its giving trouble in connection with the low-pressure piston. From what you say, however, we are inclined to believe that the seat of the trouble lies in the connection between the piston and the piston rod. Unless the bearing in this case is of considerable length and very accurately adjusted you will be liable to have considerable trouble of the sort indicated. It is possible that there is some little play in this joint, which would make the piston bind during a certain part of the stroke.

Q. 391.—Will you explain with sketches the turbine system used on the Cunard liners *Mauretania* and *Lusitania*. I particularly desire information as to the manner in which the propeller is reversed. Is this done simply by transferring the steam from one end of the shaft to the other and allowing it to escape? T. M. K.

A.—The propeller is reversed by simply transferring the steam from one end of the turbine cylinder to the other. To



go ahead, the steam is admitted to the forward end, and impinges on suitably arranged turbine vanes. The astern turbine is composed of vanes arranged in the opposite direction, and the steam is admitted at the after end of the cylinder, means being provided that steam cannot possibly be admitted to both ends at once. The steam passes direct to the condenser through a common exhaust pipe. When not working, the astern turbine revolves idly in a vacuum. The sketch shows the outline of this arrangement. E. M. S.

In actual operation, the steam from the throttle passes through a ring or girdle of stationary guide blades, by which it is directed upon a ring of blades or vanes mounted on the rotor at an angle, much like the blades of a wind-mill. The action of the steam gives this rotor an impetus. The steam then passes through a second set of guide blades, which direct it upon a second ring of rotor blades, to which it imparts a further impetus. In this way the steam traverses, in a sort of zigzag path, the length of the turbine.

SELECTED MARINE PATENTS.

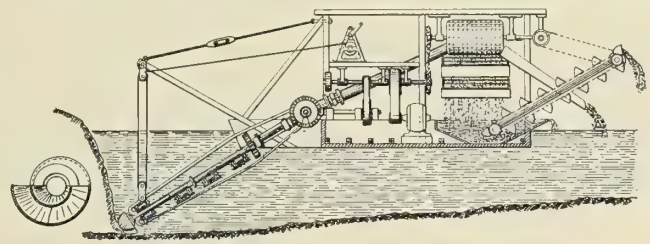
The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

868,774. DREDGING APPARATUS. THOMAS R. GOTH, SAN FRANCISCO, CAL.

Claim.—5. In a dredger, a submerged or partially submerged pipe, and a rotary snail-shell shaped digger at the extremity of said pipe, said digger having a single cutting edge and a single inlet opening in its periphery.

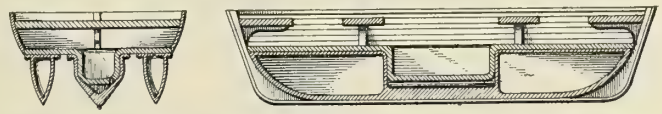
18. In a dredger in which material is drawn and forced through and beyond an intake pipe by the action of a hydraulic giant, means for



freeing the intake pipe, comprising a valve located beyond the giant and adapted to close the discharge passage; whereby the stream from the giant is forced backwardly through the intake pipe. Nineteen claims.

870,738. BOAT. CHARLES H. MYERS, BUFFALO, N. Y.

Claim.—2. In a boat, the combination with a body member having a bottom and a chamber depending below said bottom of a keel member secured to the body and located below the bottom thereof, said keel



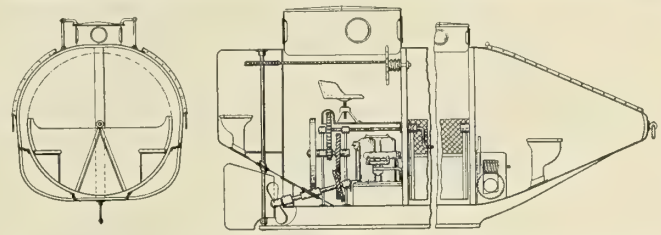
member having a pocket between its ends that receives the depending chamber, and being furthermore provided with air chambers located on opposite sides of the pocket. Eight claims.

870,758. BOAT-PROPELLING DEVICE. WHITING ARNOLD, MANDARIN, FLA.

Claim.—1. The combination with a floating vessel, of a driving shaft provided with a crank, means for rotating said shaft, a bar pivotally connected with the crank, a paddle on the lower end of said bar, and a stay-rod pivoted at its lower end to the vessel and at its upper end to the upper end of the bar carrying the paddle. Two claims.

870,928. LIFE BOAT. ROBERT A. BROWN, CHICAGO.

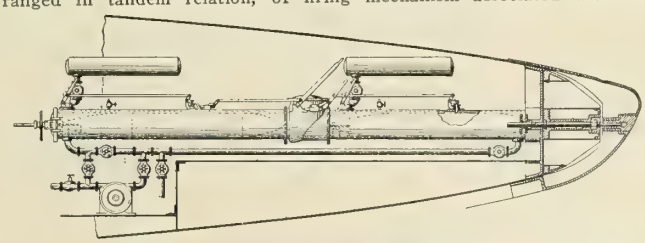
Claim.—1. A life boat comprising a closed outer shell, a car journaled within said shell on an axis disposed longitudinally, and free to rotate with respect to the outer shell, said outer shell being of non-circular transverse section below the axis of said car and being closer to said



car at each side of the axis thereof and near the middle of the bottom than at intermediate points, and ballast compartments formed at each side of the middle in the space between the car and hull, the inner surfaces of said compartments being of substantially circular transverse section and concentric with the axis of said car, and said compartments being spaced apart to allow the car to hang close to the outer hull between them. Three claims.

871,453. TANDEM TORPEDO TUBE. LAWRENCE Y. SPEAR, MILTON, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, A CORPORATION OF NEW JERSEY.

Claim.—1. The combination with a plurality of torpedo tubes arranged in tandem relation, of firing mechanism associated with the



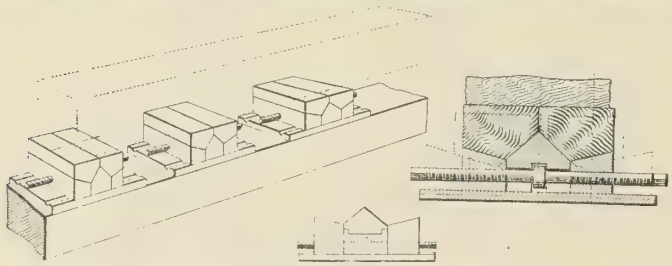
forward tube, means for establishing a firing passage from an after tube through the forward tube, and firing mechanism associated with that after tube, whereby a plurality of torpedoes may be discharged in rapid succession. Eleven claims.

871,050. PROPELLER. FREDERICK A. DOUSE, SEATTLE, WASH.

Abstract.—This invention relates to the propulsion of marine or aerial vessels; and its object is the provision of devices of this character which will be of simple and inexpensive construction, and which are capable of propelling a vessel at a high rate of speed with a relatively small consumption of power. To these ends the invention consists of a flexible blade which is adapted to be swept from side to side, and to act against the buoyant fluid to propel the vessel through a succession of reacting impulses. Two claims.

871,467. KEEL-BLOCK FOR SHIPS. THOMAS H. ALCORN, PHILADELPHIA, PA.

Claim.—1. In a device of the character described, movable supports, blocks carried by said supports, and means in engagement with the sup-



ports for operating said supports whereby the blocks are lowered, and for returning said supports to their normal position. Seventeen claims.

871,469. AUTOMATIC COALING APPARATUS. AUGUST BLIEDUNG, HAMBURG, GERMANY.

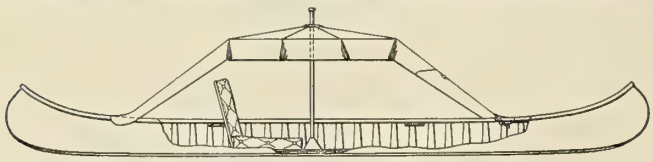
Claim.—In a coaling apparatus, a deck, a chamber beneath the deck and having lower openings, rollers within the chamber, a chain engaging the rollers and arranged in a plane parallel to the deck, and buckets carried by the chain. One claim.

871,544. DREDGE. JOHN B. WEBBER, JR., TOLEDO, OHIO, ASSIGNOR TO ALEXANDER BACKUS, TOLEDO.

Claim.—1. A hydraulic dredge having a suction pipe, a rotary head, a driving shaft therefor, a pivotal mounting for the shaft and pipe, and a thrust bearing for the shaft adjacent the mounting. Six claims.

872,088. CANOE AWNING. WILLIAM B. SHERMAN, DORCHESTER, MASS.

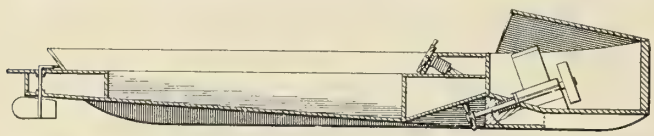
Claim.—2. In an awning, a plurality of ribs carrying an awning cloth, a supporting rod, an upper rib-ring moving freely on said rod, a slid-



ing sleeve mounted on said rod, a lower rib-ring secured to the base of said sleeve, the top of said sleeve engaging with said upper rib-ring when the awning is opened, and maintaining said rings at a fixed distance from each other. Six claims.

872,389. BOAT. ELAH TERRELL, COLUMBUS, OHIO.

Abstract.—The invention has for its object the provision of a novel construction for a power-driven boat, the construction being such that



the action of a propeller exhausts the water from in front of the boat and the follow wave, kicked up by the propeller, acts against an inclined plane bottom in such manner that the follow wave acts to drive the boat forward. Three claims.

British patents compiled by Boughton & Co., patent agents, 276 High Holborn, London, W. C.

14,617. VALVES. H. RUSTAD, LINDSAY, CANADA.

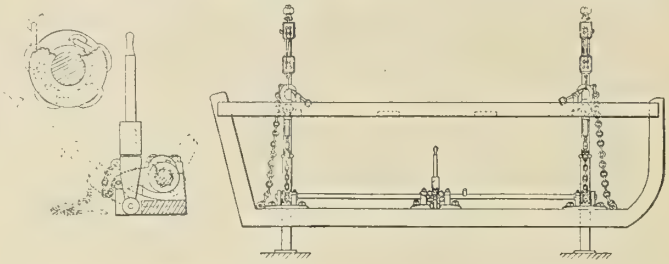
Relates to valves of the kind that can be ground after being seated. The screw spindle is in engagement with a nut having recesses in engagement with lugs in the bonnet, which covers the body portion of the valve casing. A spring tends to press the nut down. The lower end of the valve spindle is enlarged and provided with lugs which lie in recesses formed in the valve, the recesses being larger than the lugs, so that when the valve is fully down, the further turning of the spindle in either direction causes the valve to be ground in its seat. A nut secures the valve to the spindle.

15,882. MARINERS' COMPASSES. G. W. HEATH, CRAYFORD, KENT.

The gimbal knife-edges rest in saddle pieces, connected by horizontal springs to sockets on brackets, which are attached to the piece on the binnacle bowl by milled nuts. The cylindrical rim of the binnacle bowl has formed on it a second bead, between which and the upper bead engages the bolt of a locking device, for the binnacle top, which is operated by a pin engaging a cam groove in a rotatable cap. The cap rotates about the stud, and is limited in its movement by a notch in the cap engaging a stop on the base. The glazed bezel is attached to the compass bowl by studs thereon engaging a flange in a rotatable knob on the bowl, an opening in the flange allowing the stud to be inserted. For taking rapid cross-bearings, a glazed ring is rotatably fitted in the cover, and has hinged to it sighting-leaves; or a conical sight vane may be employed, provided with a graduated glass disk attached to the metal plate, which is rotatable on a spindle mounted on gimbals. A double pointer is secured to the hollow stem of the vane, which may be clamped to the spindle, which carries a fixed pointer.

15,120. BOAT DISENGAGING GEAR. E. EKBLOM, PLAISTOW, LONDON.

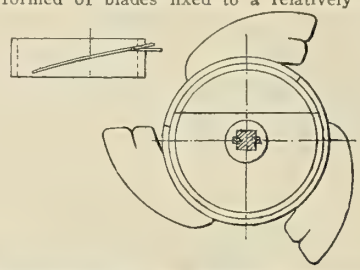
The boat is suspended from hooks secured to chains attached to a rotatable shaft by other hooks. The shafts are mounted in bearings and are provided with arms normally secured by a lever. By removing



a stop-pin and folding down the lever, the arms are released and the rotation of the shafts releases chains, putting the weight of the boat on the second chains. When the pull comes on these chains, hooks are drawn out of engagement with links, and the boat is released from the falls.

15,892. SCREW PROPELLERS. C. J. H. FLINDT, OROSUNDSGADE, COPENHAGEN, DENMARK.

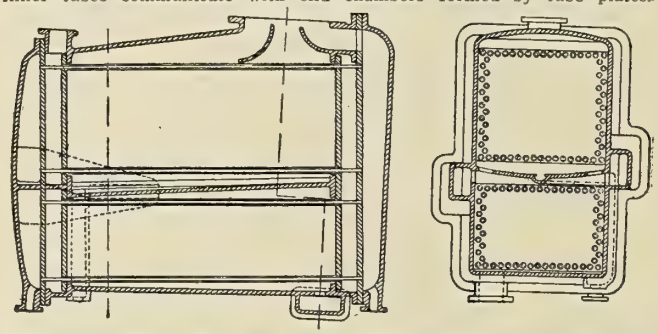
In propellers formed of blades fixed to a relatively large hub, each



blade is split longitudinally at the broadest end into two parts, the inner tip being of larger pitch than the outer.

16,091. STEAM CONDENSERS. T. W. AND W. W. NICHOLS, GATESHEAD, DURHAM.

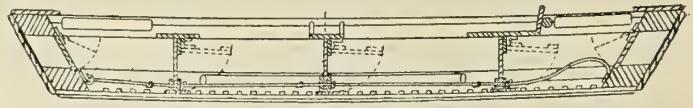
In a horizontal steam condenser of the concentric tube type the tubes are slightly inclined, while various draining passages are provided to carry off more rapidly the water of condensation. The outer and inner tubes communicate with end chambers formed by tube plates.



The tubes are fixed to the tube plates by means of perforated sleeves and gland nuts, the arrangement of which may be slightly varied. The end compartment, divided by a diaphragm, is connected by ducts with the main chamber, which is also divided by a curved plate having a drain groove. Water flows through the annular spaces between the concentric tubes, and is caused by baffles, inserted in the end chambers, to pass backwards and forwards through the condenser.

16,369. COLLAPSIBLE BOATS. C. ADDISON WILLIAMSON, KOOLUNGA, SUFFOLK.

In collapsible boats of the kind which are formed with a rigid and approximately flat bottom and a gunwale connected to the bottom by flexible sides, the seats have legs hinged under them, by which the boat is maintained in its extended position. The bottoms of the legs



rest on the inside of the bottom of the boat, and are connected together by a rope. To collapse the boat, the rope is pulled, causing the legs to assume a horizontal position. When the boat is in the open position, the rope is placed over a hook.

16,556. LOADING AND UNLOADING VESSELS. T. G. F. McCOMBIE, MONKSTOWN, DUBLIN.

For coaling or loading ships at sea, a tube is connected at one end to a feeding apparatus on the collier and at the other end to a port in the side of a vessel towed by the collier, the joint being watertight. Bags of coal are fed along the tube on the collier, and are delivered into a flexible tube, which conveys them through the port into the vessel. The feeding apparatus consists of slide plates which engage a screw shaft and are thus moved along, pushing the bags in front. The slot in the bottom of the tube is turned at right angles, and so the slide plates on reaching this point automatically drop out of action.